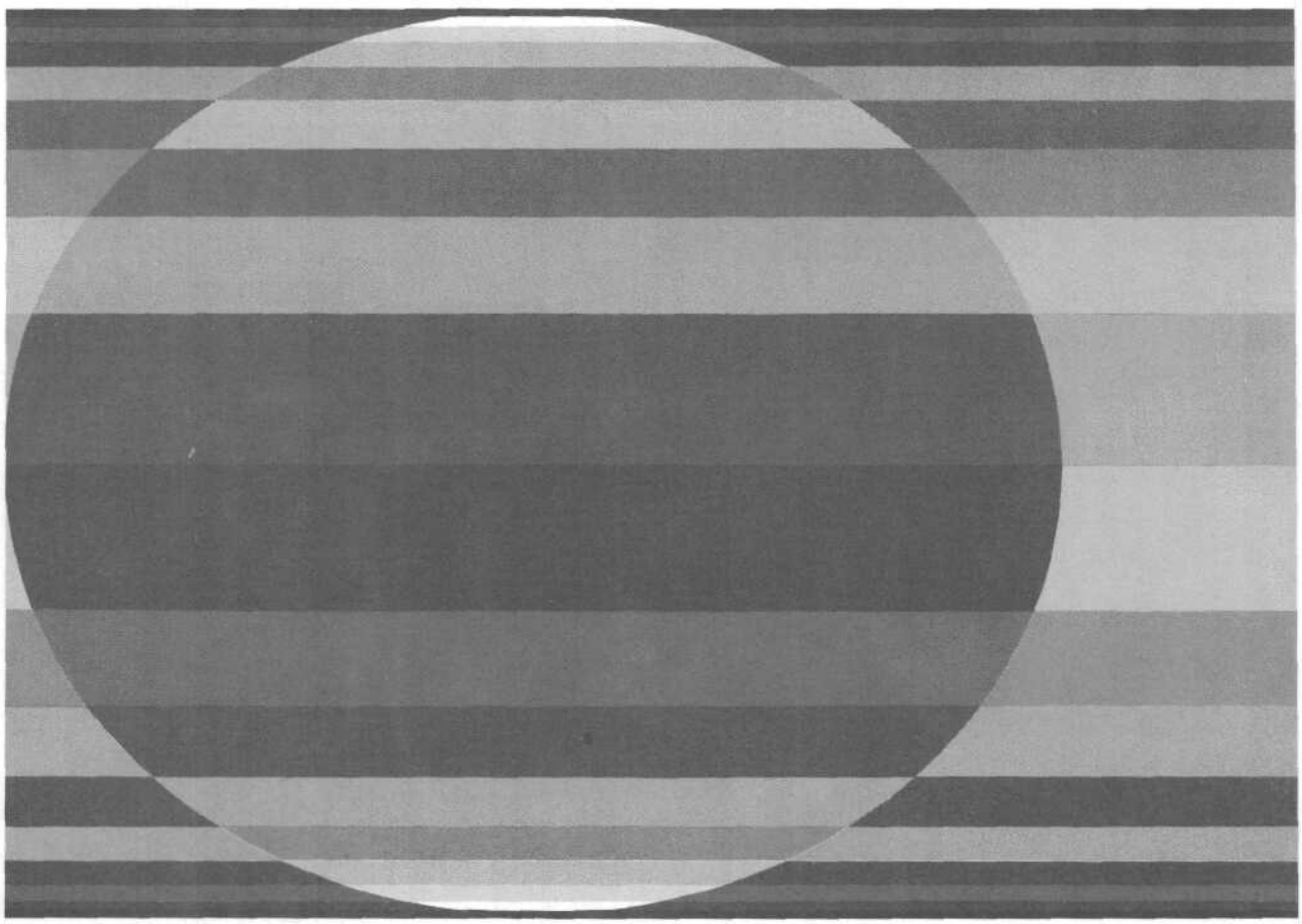
BACKGROUND PAPER

U.S. Air and Ground Conventional Forces for NATO: Air Defense Issues

March 1978



Congress of the United States
Congressional Budget Office

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
MAR 1978		**00-00-1978 to 00-00-1978**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
U.S. Air and Ground Conventional Forces for NATO: Air Defense Issues	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Congressional Budget Office,Ford House Office Building, 4th Floor,Second and D Streets, SW,Washington,DC,20515-6925**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**		**81**	

U.S. AIR AND GROUND CONVENTIONAL FORCES FOR NATO: AIR DEFENSE ISSUES

The Congress of the United States
Congressional Budget Office

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402

PREFACE

The defense budget that the Congress will consider for fiscal year 1979 emphasizes the improvement of U.S. air and ground conventional forces for NATO. The effectiveness of these forces is closely related to the capabilities of our NATO allies. Therefore, the allies' contribution to NATO's defense should be considered in making decisions on U.S. conventional forces.

This paper discusses NATO's air defenses. It evaluates U.S. and allied capabilities in this area and presents options for U.S. decisions on procurement of air defense systems. The paper is part of a CBO series on the U.S. military role in NATO. Other papers in this series are Assessing the NATO/Warsaw Pact Military Balance (December 1977), U.S. Air and Ground Conventional Forces for NATO: Overview (January 1978), and two companion background papers, Firepower Issues and Mobility and Logistics Issues. This series was undertaken at the request of the Senate Budget Committee. In accordance with the Congressional Budget Office's mandate to provide objective analysis, this report offers no recommendations.

This paper was prepared by Marshall Hoyler of CBO's National Security and International Affairs Division, under the supervision of John E. Koehler and James R. Blaker. The author is indebted to Nancy Bearg, who served as a consultant. The author also gratefully acknowledges the contributions of Sheila Fifer, Andrew Hamilton, Daniel Huck, G. Philip Hughes, John Shewmaker, Peggy Weeks, and Dov Zakheim. Cost analysis was provided by Edward Swoboda of CBO's Budget Analysis Division. Several drafts were typed by Connie Leonard. The manuscript was edited by Patricia Johnston and prepared for publication by Nancy Swope.

Alice Rivlin
Director

March 1978

CONTENTS

TABLES

FIGURE

SUMMARY

Investment in air defense will cost about $22.5 billion over the next five years if current programs remain unchanged. Different mixes of ground-based and airborne air defenses explored in this paper could lead either to savings of $2.6 billion between fiscal years 1979 and 1983 or to added costs of $2.0 billion over the same five-year period, when compared to the costs of maintaining current policy. Savings would follow if improvements were restricted to enhancing the air defenses of U.S. forces; increased costs would result from an effort to enhance the allies' air defenses as well.

The primary justification for air defense forces, and for U.S. conventional ground and air forces in general, is the defense of NATO's Central Region (that is, West Germany) against a possible attack by the Warsaw Pact. Thus, improvements in these forces are made on the presumption that they will strengthen NATO's defenses against the Warsaw Pact.

Regardless of the improvements that are made in U.S. forces, however, the overall strength of NATO's defenses will depend to a large extent upon the Western European allies. England, Belgium, Holland, and West Germany provide about three-fourths of NATO's ground and air forces in Central Europe. The ground units from these countries are stationed in, and responsible for defending, northern Germany--the area of the Central Region with the most favorable terrain for a Warsaw Pact attack.

Yet, the allies' defenses in northern Germany are weaker, in terms of logistical and firepower capabilities, than those of the U.S. and German sectors to the south. This endangers the defense of Western Europe, since a successful attack in the north could outflank U.S. and German forces in southern Germany and collapse NATO's defenses before major reinforcements could arrive. Thus, Congressional decisions on the U.S. contribution to NATO's defense in general, and on air defense in particular, should be made not only in light of the threat posed by the Warsaw Pact, but also in view of the allies' present capabilities and the improvements that are expected to be made to their forces in the future.

34-760 O - 78 - 2

THE WARSAW PACT THREAT

Arguments for improving NATO's air defenses are based primarily on improvements in Warsaw Pact air forces over the past decade. The Pact has increased the number of its aircraft that can attack ground targets and has introduced aircraft that can carry larger payloads over greater distances than those formerly deployed.

The Pact's overall air attack capabilities, however, are still considerably inferior to NATO's, and air-delivered firepower remains small compared to what the Pact could deliver with artillery and rockets. In addition, the Pact's capability to deliver ordnance accurately in close support of ground troops or in conditions of low visibility is not impressive and is not expected to improve much over the next decade.

Despite these limitations, Warsaw Pact air forces endanger NATO, since they could rapidly exploit any weaknesses in NATO's defenses that might appear in battle. Furthermore, Pact aircraft could be concentrated in support of a Pact ground attack. In that situation, even though Pact air power might add only marginally to the Pact's overall firepower capabilities at the front, the addition could be very significant. When combined with the power of a Pact offensive against weaknesses in NATO's defenses on the ground, the Pact's air power might permit a Pact attack to succeed. Thus, NATO's air defenses are key not only to limiting the effectiveness of the Pact's air power, but to providing for a viable overall defense as well.

THE MISSION AND STRUCTURE OF NATO AIR DEFENSES

Air defenses restrict enemy air power from impeding friendly operations. Passive air defenses (such as hardening, dispersing, and concealing potential targets) make targets more difficult to detect and destroy. Active air defenses (such as fighters, anti-aircraft guns, and surface-to-air missiles) destroy aircraft or cause them to fail in their missions in other ways. Since most of the procurement programs currently before the Congress involve active systems, they are the primary subject of this paper.

Active Air Defenses

NATO active air defense systems in the Central Region pose a series of challenges to attacking Warsaw Pact aircraft: detection

by early warning radars, attack by long-range surface-to-air missiles (SAMs) and fighter aircraft, and the threat of short-range SAMs and anti-aircraft (AA) guns. These systems are to some extent deployed so that an attempt to exploit the weaknesses of one system would expose an attacker to another danger. Also, because it is difficult to predict where a Warsaw Pact attack might occur, most NATO active air defense assets in the Central Region are controlled by a single allied commander, even in peacetime. This allows rapid and efficient response to a sudden attack.

There are, however, important differences in how NATO members defend their rear areas. Several countries contribute to a belt of long-range SAMs deployed along the inter-German border. But unlike the United States, the allies typically do not deploy their Hawk SAMs in depth. In allied sectors, therefore, enemy aircraft would not be threatened by SAMs once they had penetrated the belt. Attackers would, however, face heavier anti-aircraft gunfire in allied sectors, since the allies deploy more AA systems than the United States does.

Because ground-based air defense in Germany is composed of different kinds of systems whose relative effectiveness in combat is not precisely measurable, it is hard to predict areas of possible weakness. Allied and U.S. fighters provide one means of coping with this uncertainty and of offsetting possible flaws in the ground-based deployments. Fighters are highly mobile, and the centralized control system permits them to be sent where they are most needed.

FUTURE CHANGES

Although problems exist with NATO's currently deployed air defense systems, its air defenses are likely to become stronger in the future.

Allied Programs

The Germans, Belgians, and Dutch are acquiring large numbers of self-propelled, radar-guided anti-aircraft guns. In addition, the German and French armies are procuring a short-range, radar-guided SAM, called Roland. The Belgian and Dutch air forces plan to buy the F-16, a fighter with excellent potential for visual-range, air-to-air combat. The German air force is replacing its

F-104s with F-4F Phantoms and is modifying this aircraft to enhance its capability. The British plan to procure an air defense variant of the Tornado fighter-bomber and arm it with the radar-guided Skyflash missile, thus providing this aircraft with all-weather potential.

U.S. Programs

The United States plans to replace its Nike-Hercules and Hawk missile batteries in Europe with the expensive Patriot SAM. Patriot is superior to Nike-Hercules, but its cost-effectiveness as a replacement for Hawk is less clear. Changes in U.S. short-range air defense systems have also been proposed. Acquisition of the all-weather Roland SAM has begun, and development funds for a new self-propelled, all-weather anti-aircraft gun have been requested.

Other changes involve airborne or airborne-related air defense systems. One such change, already implemented to a large extent, is the acquisition of the E-3A AWACS aircraft, an early warning radar aircraft that may assist in managing air battles. The United States also plans to buy F-15 and F-16 fighters. Finally, the United States is building facilities to shelter planes on the ground and to permit reinforcement aircraft from the United States to be dispersed to allied bases in time of war.

OPTIONS 1/

While NATO's air defenses are getting better, the Congress still must determine the direction for further U.S. improvements. Since successful air defense in NATO depends on allied capabilities, one basis for deciding among U.S. air defense procurement programs should be an explicit judgment about how such programs would complement allied efforts.

1/ These options correspond to ones specified in Congressional Budget Office, U.S. Air and Ground Conventional Forces for NATO: Overview (January 1978). The options presented in the Overview paper include procurement of firepower and logistical capabilities as well as those needed for air defense; the options in this paper are restricted to air defense systems.

The United States contributes to NATO's defenses in three general ways: augmenting the allied ability to defend their sectors; reinforcing NATO with U.S. ground forces located outside of Europe; and defending the U.S. sectors in southern Germany. Decisions on air defense can be viewed in this framework, suggesting the options below. The air defense procurement packages proposed under each option illustrate the implications of decisions to emphasize one of these roles; they are not necessarily cost-effective.

Several systems are common to all three options. Among the most important of these are:

- Partial deployment of Patriot and retention of Hawk, because of procurement savings and the improved effectiveness of Patriot in comparison to the currently deployed Nike-Hercules SAMs.

- Procurement of large numbers of relatively inexpensive anti-aircraft guns, rather than a smaller number of more costly all-weather systems, because of the Pact's poor all-weather ground attack capability and the proven effectiveness of large numbers of guns.

- Continued procurement of the Roland SAM, because of the effectiveness of its radar guidance in hedging against unexpectedly swift improvements in Pact all-weather ground attack capability.

The costs of the three options are summarized in the table that follows.

Option I. Providing Aircraft to Augment Allied Defenses

One role the United States now plays in NATO is providing aircraft that can offset possible weaknesses of allied forces in northern Germany. The Congress may decide that the United States should enhance its capabilities to perform this role by providing additional air defense aircraft. The mobility and inherent flexibility of these aircraft would enable them to assist either U.S. forces or those of its allies, depending on where the needs were greatest.

Additional air defense aircraft would perform two important tasks. One would be to defend the A-10 ground attack aircraft,

COSTS OF OPTIONS IN COMPARISON TO CURRENT AIR DEFENSE PROCUREMENT: BY FISCAL YEAR, IN MILLIONS OF CURRENT DOLLARS

Option	1979	1980	1981	1982	1983
Current DoD Program	4,420	5,120	5,060	4,060	3,650
Option I: Providing Aircraft to Augment Allied Defenses					
With Additional F-16 Procurement	0	440	430	530	630
With Employment of Navy and Marine Air	30	30	35	20	25
Option II: Providing Air Defenses for an Additional U.S. Corps to Reinforce Allied Sectors					
With Additional F-16 Procurement	0	440	430	100	200
With Employment of Navy and Marine Air	30	15	20	5	5
Option III: Modernizing Air Defenses for Smaller U.S. Forces	0	-460	-1,160	-460	-520

NOTE: All three options include $109 million to cover procurement of 1,000 Rheinmetall AA guns with ammunition for use in Europe. This sum is not included in the figures above.

a major element in this option. 2/ Another would be compensating for the lack of in-depth Hawk SAMs in allied rear areas.

These missions can be performed in two ways. If only Air Force assets were used, the addition of two F-16 wings might be sufficient. This alternative would imply an investment of roughly $2 billion over currently planned spending over the next five fiscal years. A much less expensive alternative would involve bringing fighters and attack aircraft from two Navy carrier air wings and one Marine wing into the Central Region. Such a decision would require that some materiel needed for wartime operations be prepositioned at existing European airfields. This alternative would add only $140 million to currently planned spending over the same five-year period.

Option II. Providing Air Defenses for an Additional U.S. Corps to Reinforce Allied Sectors

A second role the United States currently plays in NATO involves the capability to reinforce the Central Region with ground forces from the United States. A decision to enhance this role would probably imply prepositioning of materiel for an additional U.S. corps in northern Germany.

This means of reinforcement would increase the number of AA guns and short-range SAMs available in northern Germany and reduce the need for A-10s. Consequently, fewer F-16s would be needed than in Option I. Accordingly, this option would cut one wing of F-16s from the number proposed in Option I. One wing more than currently planned would remain, however, on the grounds that the addition of a U.S. corps in northern Germany would not offset the lack of in-depth Hawks there.

Procurement of an additional wing of F-16s would cost about $1.17 billion over the next five fiscal years. Again, the addition of one wing of F-16s would not be necessary if provisions were made to use Navy and/or Marine assets instead. Such provisions would cost about $75 million over the same five-year

---

2/ The Overview paper in this series suggests adding two wings of these specialized ground attack aircraft to the force; defending them would create an additional possible demand on NATO fighter resources.

period. Thus, the cost of this option could vary greatly, depending on how U.S. capabilities to defend northern Germany with fighters were enhanced.

Option III. Modernizing Air Defenses for Smaller U.S. NATO Forces

The Congress might, for a number of reasons, wish to reverse the trends toward increased spending on U.S. forces for NATO and an increased U.S. role in the alliance. One means of doing this would be to delete three divisions that have been added to Army ground forces since fiscal year 1974, but to continue modernization of the equipment used by the other 13 divisions in the Army. This policy would amount to a decision to emphasize the third role the United States now plays in NATO: defense of the U.S. sectors in southern Germany.

Under this option, current Air Force procurement plans could be changed considerably. Since U.S. fighters in the Central Region are under centralized NATO command, many of them could be dispatched to augment the allies' defenses should they prove weaker in time of war. Procurement of additional U.S. fighters might therefore be a means of reinforcing the defenses of northern Germany more than those of U.S. sectors. As a result, this option proposes a cut of one wing each in F-15 and F-16 procurement from present Defense Department plans. Such a cut would yield savings of $2.6 billion over the next five fiscal years.

CHAPTER I. INTRODUCTION

Investment in air defense will cost about $22.5 billion over the next five years if current forces and funding levels remain unchanged. The primary justification for these costs is not air defense of the continental United States, but rather improvement of the U.S. capability to help defend Western Europe, especially NATO's Central Region in West Germany.

Regardless of improvements made in U.S. forces, however, the overall strength of NATO's defenses will depend largely upon the Western European allies. They provide the bulk of NATO's forces in Europe and are responsible for the defense of northern Germany--the area of the Central Region that is thought to have the most favorable terrain for an attack by the Warsaw Pact (see Figure 1). Therefore, decisions about air defense procurement should not be made simply in light of the capabilities of the air forces of the Soviet Union and its allies in the Warsaw Pact. These decisions should also be based on an examination of the air defense capabilities of NATO allies in the Central Region and of the relation between their capabilities and those of the United States. This paper discusses each of these topics. 1/

AIR DEFENSE DEFINED

In the context of a NATO/Warsaw Pact war, air defense can be defined as the reduction of the ability of Warsaw Pact air power to impede NATO operations. It is fundamental to a successful NATO response to an attack by Warsaw Pact forces. 2/

1/ This paper is one of four in the CBO series on U.S. Air and Ground Conventional Forces for NATO. The other papers include an Overview budget issue paper and two background papers on Firepower Issues and Mobility and Logistics Issues.

2/ The air defense mission is a subset of a larger mission the Air Force calls counterair, which also covers offensive warfare against Warsaw Pact aircraft and related facilities

24-760 O - 78 - 3

Figure 1.
Corps Sectors of Military Responsibility in NATO's Central Region

SOURCE: Adapted from Richard Lawrence and Jeffrey Record, *U.S. Force Structure in NATO* (Washington, D.C.: The Brookings Institution, 1974), p. 31 and also from U.S. Army materials.

a/ NORTHAG (Northern Army Group) and CENTAG (Central Army Group) are the two subdivisions of NATO forces in West Germany. The line dividing the two runs from Belgium through West Germany, just south of Bonn, and into East Germany.

Air defense is accomplished with passive and active systems. Passive air defense makes targets harder to find and destroy. It has been very effective historically, and it is also relatively cheap. One reason for this is that passive defenses tend to be "one-time" investments. Passive measures include dispersal, concealment, and "hardening" (that is, fortification) of potential targets.

Active air defenses destroy aircraft or cause them to fail in their missions in other ways. Active airborne systems include combat aircraft, their missiles, and early warning aircraft; active ground-based systems include radars, surface-to-air missiles (SAMs), and anti-aircraft (AA) guns.

Active air defense systems are the primary subject of this paper because they form the bulk of the procurement programs now before the Congress. This does not necessarily mean that it is correct to assume that active systems are more important than passive ones or that active systems can improve NATO's air defenses more than passive ones can. Current Defense Department spending priorities, however, do reflect these assumptions.

Air defense does not necessarily imply destruction of enemy aircraft. For example, the following ways of reducing the effectiveness of the Warsaw Pact air effort would constitute successful air defense:

- Forcing enemy aircraft to fly faster, higher, or lower than preferred, 3/ thereby dropping their ordnance with

---

in and over Warsaw Pact territory. This paper will not address the whole spectrum of counterair; its primary focus will be on systems that are justified for inclusion in the budget on grounds that they enhance NATO's air defenses. Therefore, this paper discusses primarily defensive systems and the employment of aircraft (which can be both offensive and defensive) in defensive roles in and over NATO territory.

3/ Unless the enemy can launch precision-guided munitions from above AA gun range, air defense can be enhanced if AA guns force attacking aircraft to fly a few thousand feet higher. (The North Vietnamese significantly reduced the accuracy of some U.S. bombing attacks by deploying large numbers of AA guns which forced just such an increase in release altitude.)

less accuracy, and cutting the distances at which they can attack targets by increasing their fuel consumption. 4/

- o Forcing enemy aircraft to abort their missions or to devote scarce aircraft resources to countermeasures against air defense systems. 5/
- o Denying enemy aircraft lucrative targets by sheltering NATO aircraft and by hardening and camouflaging other critical targets.
- o Jamming the radars of enemy aircraft.

These means of reducing enemy effectiveness would be most relevant when the enemy was seeking a quick decision in a short war; attrition of enemy aircraft and pilots would become a progressively more important aspect of air defense as conflict was prolonged.

THE NATURE OF THE THREAT

NATO air defense systems are needed to counter large numbers of Warsaw Pact aircraft that are increasingly capable of performing ground attack missions. An overview of this threat is provided here; supporting detail is supplied in Appendix B.

4/ To achieve maximum fuel efficiency and therefore maximum range for attacking NATO targets, Pact aircraft would have to fly to and from the target at high altitude and go low only for ordnance delivery. Therefore, they would have to sacrifice either range or payload if NATO's radars, SAMs, and fighters force them to fly the entire mission at low altitude.

5/ For example, "the 5,000 to 6,000 AA positions in North Vietnam forced the Americans to devote 25 percent of their missions to neutralizing these positions and 25 percent to electronic warfare, leaving only 50 percent of the aircraft available for other operations." (Peter Bogart, "The Vulnerability of the Manned Airborne Weapon System," International Defense Review, No. 6 (1977), p. 1066.)

Between 2,700 and 3,000 Pact tactical aircraft are now estimated to be deployed in Central Europe. Soviet planes are assigned to Frontal Aviation, which includes about 1,000 tactical aircraft based in the western Soviet Union and is responsible for supporting ground forces in combat. About 500 medium-range bombers are also based there and could be used against targets in the Central Region.

Over 1,500 of the Pact inventory in Central Europe are either multirole fighters capable of ground attack or aircraft specifically designed for this mission. The Soviet Union also has deployed around 300 Mi-24 Hind attack helicopters, which some see as a serious threat to NATO tank forces. These figures represent considerable change since 1968, when air-to-air fighters outnumbered ground attack aircraft by about 2 to 1 and when the overall Pact aircraft inventory was 11 percent smaller. The increase in force size has been accompanied by qualitative improvements. More advanced aircraft with greater range and payload capabilities have been added.

Although the Pact air threat to NATO is increasing, it has important limitations. The amount of ordnance that the Pact Frontal Aviation force could deliver in a given period of time is extremely small in comparison to the tonnage that could be delivered by Pact ground forces 6/ along the forward edge of the battle area. 7/ The amount of ordnance the Pact air forces could deliver would become markedly smaller during the bad weather frequently experienced in the Central Region. 8/ This is because

---

6/ It is also very small in comparison to the tonnage deliverable by the numerically smaller NATO air forces. See Congressional Budget Office, Assessing the NATO/Warsaw Pact Military Balance, Budget Issue Paper (December 1977), p. 37.

7/ The services use the acronym "FEBA" to refer to this swath of territory in which enemy and friendly troops are in contact. This paper will hereafter use the term "front."

8/ Compared to ground-based systems, aircraft can hit more distant targets and can be massed against a given portion of the front more quickly. Nevertheless, it is important to examine in detail the threat posed by Pact aircraft to NATO units near the front, because the Army plans to make substantial investments in all-weather air defense systems that are earmarked to be used there.

Pact capability for all-weather ground attack is not impressive and seems likely to show only limited improvement in the next decade. Nevertheless, because clear weather means a proportionally greater increase in NATO firepower potential than in Pact firepower potential, there is reason to believe that the Pact would not choose to launch an attack under such conditions. If so, the clear-weather scenario on which official plans seem to be based is somewhat implausible, and the probable dimensions of the air threat are to that extent overestimated.

The Pact air forces have problems even in clear weather. Many observers believe that Pact fixed-wing aircraft have little capability to score hits on small, hard, dispersed targets, such as tanks. The skill of Soviet pilots may also be deficient. They "spend only about 60 percent as much time in training as U.S. pilots." 9/ Also, they may not be able to operate well with their Warsaw Pact counterparts. 10/ In addition, Warsaw Pact "tactics and strategy are often stereotyped, the control system is frequently rigid, and initiative at lower levels of command is proscribed." 11/ Finally, the Pact maintenance system seems considerably less capable than that of NATO forces, suggesting that Pact wartime sortie rates would be lower than those NATO could achieve with a substantially smaller force. 12/

Many who have studied Soviet doctrine believe that, if the Soviets were to attack Western European territory conventionally, Warsaw Pact air power would be used as follows. First, the Pact would try to clear corridors in the NATO air defense system by attacking NATO SAM sites. Next, they would attack high-value targets important to NATO's response, such as airfields, nuclear

---

9/ Robert P. Berman, Soviet Air Power in Transition (Washington, D.C.: Brookings Institution, 1978), p. 57.

10/ Clarence Robinson quotes U.S. officers in Europe: "We do not know the degree the Russians can rely on Pact forces . . . [or] . . . their ability to communicate with them in a standard language. (See "Increasing Soviet Offensive Threat Spurs Stronger Europe Air Arm," Aviation Week and Space Technology (August 1, 1977), p. 46.)

11/ Ibid.

12/ Berman, Soviet Air Power in Transition, p. 58.

weapons storage sites, and command and control centers. After the initial attacks, surviving aircraft could turn to support of attacking ground forces, though some attacks on high-value targets would probably continue.

All these actions would take place in concert with ground attacks, for Soviet doctrine sees tactical air power as a supplement to, not a substitute for, its ground forces. Thus, in the event of a conflict, Soviet air attacks might well be concentrated against NATO's Northern Army Group (NORTHAG) area (see Figure 1). Terrain there favors the kind of armored resources and tactics used by Pact ground forces, and the allied forces stationed in NORTHAG are weaker in firepower and in the ability to sustain intense combat than the U.S. forces stationed in southern Germany. 13/ Thus, in the context of a major ground attack against NORTHAG, Pact air attacks might play a critical role, despite their limited ability to deliver large tonnages of ordnance against NATO targets. The marginal destruction brought about by Pact air power, when added to the power of a Pact ground offensive, might permit the Warsaw Pact to break through NATO's defenses in the north before NATO could reinforce that region, thereby outflanking U.S. forces in southern Germany.

13/ For extensive discussion of these issues, see Congressional Budget Office, U.S. Air and Ground Conventional Forces for NATO: Overview, Budget Issue Paper (January 1978) and the companion background papers, Firepower Issues and Mobility and Logistics Issues.

CHAPTER II. AN OVERVIEW OF AIR DEFENSE IN THE CENTRAL REGION

Since the Warsaw Pact air force is highly mobile, likely avenues of approach to specific targets are not easy to predict. As a result, both NATO air defense command relationships and the way systems are deployed to defend NATO airspace must be ready to respond to an attack wherever it might occur. Each of these aspects of Central Region air defense is discussed below.

AIR DEFENSE COMMAND RELATIONSHIPS FOR THE CENTRAL REGION

A Warsaw Pact air attack could be mounted with very little warning. This means there could be little time for NATO air defense organizations to shift from command relationships acceptable in peacetime to those required for combat. Therefore, the Commander of Allied Air Forces Central Europe (ComAAFCE) has peacetime operational control of some of member nations' assets, namely air defense fighters, SAMs, and fixed and mobile radar. In wartime, he has command of all remaining allied tactical air assets as well.

The two commands immediately subordinate to ComAAFCE are termed Allied Tactical Air Forces (ATAFs). 1/ ComAAFCE can allocate aircraft from one ATAF to the other, depending on his assessment of where the need is greatest. Thus, the mobility advantage technically possible with aircraft is not constrained or frustrated by allied command arrangements, and NATO air defense assets are more truly an alliance resource than are its other military capabilities.

COVERAGE OF CENTRAL REGION AIRSPACE

Air defense over the Central Region is best envisioned as Warsaw Pact pilots might see it--from east to west and from low

---

1/ The northern part of the Central Region is covered by 2 ATAF; the southern part is covered by 4 ATAF. The division between them corresponds to the division between NORTHAG and CENTAG, illustrated in Figure 1.

24-760 O - 78 - 4

to high altitudes. From this perspective, NATO's overall air defenses appear formidable.

Warsaw Pact aircraft would face detection by NATO early warning systems even before they reached NATO territory. Next, they would face fighters and long-range SAMs that provide area coverage. Most of these SAMs are deployed in a belt that runs from north to south in the Central Region and threaten Pact aircraft at all but very low altitudes. As a result, Pact attackers might try to fly below the airspace covered by these SAMs. Failing that, they must either attack SAM sites, outmaneuver the missiles, or overwhelm the SAM belt by massing aircraft at some point or by jamming the SAMs' radars.

If a Pact pilot successfully avoided destruction by SAMs in the belt, the challenges he would face would depend upon where he went next. In the vicinity of the front, he would have to continue to fly at very low altitudes to avoid long-range SAMs. Doing so, however, would expose him to AA guns and short-range SAMs under the tactical control of the ground forces.

If he moved further into NATO territory, he would be likely to encounter two kinds of defenses. Point defense systems would consist of short-range SAMs, AA guns, hardened sites, and camouflage deployed to protect specific targets. Area defense systems would vary according to whether he was flying over a U.S. or an allied sector. If he was over a U.S. sector, he might be engaged by both aircraft and long-range SAMs, unless he continued to fly very low. This is because the United States deploys some of its long-range Hawk SAMs in depth, while typically the allies do not. Therefore, if the Pact penetrator moved further into allied territory, the only area air defense system that could challenge him would be fighters.

Clearly, an attacking Pact pilot would face a redundant NATO air defense network. Two points about this redundancy should be noted. It means an attacker would have to worry about NATO's air defenses throughout his mission; if an enemy pilot slipped through the forward air defense, he would be likely to meet resistance from additional systems. It also means that a Pact pilot's efforts to exploit the weaknesses of one system would be likely to expose him to other systems. If he flew low to avoid radar and SAMs, he would move within the range of AA guns. If he flew at medium altitudes using measures to evade long-range SAMs, he would become more exposed to radar detection and fighter interception.

Although NATO's air defenses are formidable, they are not impenetrable. This is important because the components of NATO's air defenses are interdependent. For example, successful penetration of NATO's SAM belt in any sector could make NATO assets in other sectors more vulnerable to attack. Thus, a relative weakness in the SAM belt could contribute to a weakness overall, in that longer-range Pact aircraft could attack through such weaker areas.

In view of the interdependence of NATO air defenses, it is important to note that there are clear differences in approach between the air defenses of the United States and those of its allies. U.S. deployment of some Hawk SAMs in depth is one example of such differences. 2/ This may imply that U.S. sectors enjoy stronger air defenses than those of allied sectors. This conclusion is not clear, however, because the allies seem to place greater reliance on anti-aircraft guns in their sectors than the United States does in its sectors. Because of the proven effectiveness of AA guns in the air defense role, this fact may mean that targets in the rear of the allies' sectors are better protected than those in the rear of U.S. sectors.

Existing differences between the air defenses of the United States and its allies do not necessarily imply that either is relatively weak. Two things are clear, however. First, a Pact attack would seek to exploit any weaknesses that emerged because of these differences. Air attackers would be especially able to do this because of the speed with which aircraft can be oriented against defenders' weaknesses. Second, if the Congress is to make sound decisions about air defense procurement, it must be aware of these differences. For this reason, the following chapter provides a more detailed discussion of present and future differences between U.S. and allied air defenses.

2/ The U.S. sectors have not only the protection of a north-to-south belt composed of a series of Nike-Hercules SAM sites and, further forward, a series of Hawk sites, but also the protection of a number of Hawk units deployed in depth, east to west. In general, the NATO allies do not have this protection in depth. Instead, they have only a belt defense, running roughly north to south and comprised of a series of Nike-Hercules sites to cover medium to high altitudes and, further forward, a series of Hawk sites to cover low to medium altitudes. (An exception to this generalization is the fact that some Dutch Hawks are deployed in Holland.)

CHAPTER III. THE PRESENT AND FUTURE MAKEUP OF AIR DEFENSES IN THE CENTRAL REGION

The previous chapters highlighted important aspects of the context in which Congressional choices will be made regarding air defenses for the Central Region. The Warsaw Pact's improved offensive air forces could make a critical difference in an attack on northern Germany, in part because allied sectors that cover that area may have weaker air defenses than those of the U.S. sectors in southern Germany. Possible weaknesses of this kind are directly relevant to U.S. procurement decisions for two reasons: (1) a weakness in one sector's air defenses can lead to weaknesses elsewhere; and (2) through Central Region command arrangements, highly mobile U.S. fighters will be sent wherever the need is greatest.

These "possible weaknesses" result from important differences both in how the United States and its allies provide for air defense over their assigned sectors of the Central Region and in the assets they contribute to the common defense. This chapter outlines what these differences are and how they might be changed in the future. It does so briefly; additional details about many of these topics are supplied in Appendix A.

This discussion divides air defense systems into two categories: ground-based air defense systems (for example, anti-aircraft guns), and airborne air defense systems (for example, fighters) and associated facilities. This division is convenient in a discussion of differences between the United States and its allies. In the case of ground-based systems, national differences in approaches to air defense and in the weapons used are probably quite significant for the defense of individual sectors. Because of the limited mobility of ground-based systems, a sector cannot be strengthened rapidly once a war begins. In the case of fighters, by contrast, such national differences are less important for an individual sector's defense, since command of these highly mobile assets is centralized. Airborne radars and passive defenses for NATO fighters are similarly alliance resources. The following section illustrates, however, that national differences with respect to aircraft and associated facilities are important to overall alliance capability.

AIRBORNE (OR AIRBORNE-RELATED) AIR DEFENSE PROGRAMS

Shelters and Basing

Two important airborne-related programs, shelters and basing, provide passive defenses for U.S. aircraft. Through these programs, however, U.S. budget outlays tend to enhance the allies' air defense as well as that of the U.S. forces. Collocated operating bases (COBs)--allied bases with facilities for the use of U.S. planes that would deploy from the United States to Europe in a crisis--have a payoff both to the United States and to its allies. For the United States, they permit dispersed basing of U.S. planes, which is one means of passive defense. For the allies, these facilities can be used both in peacetime and, in the possibly critical early days of a European war, until the arrival of U.S. aircraft. Shelters built at U.S. main operating bases are less likely to be directly useful to allied air forces than those built at COBs. Such shelters, however, provide protection for U.S. fighters that do directly enhance allies' air defense.

Aircraft

Although aircraft are an alliance resource, there are some important differences among the kinds of planes that the United States and the allies contribute to NATO's defenses. The U.S. contribution is significant both in terms of numbers and in terms of capability. The U.S. inventory of air defense aircraft in Europe is almost one-third that of the total inventory of NATO countries committed to Central Region defense. 1/ This proportion understates the potential U.S. contribution, however, since it does not count the large number of U.S. air defense fighters based in the United States that could quickly move to Europe in a crisis. If these were counted, it would increase the American contribution to the Central Region fighter inventory to over half of the total.

1/ In other words, U.S. air defense aircraft based in Europe provide approximately one-third of the total peacetime air defense aircraft inventory in Europe of the United States, Britain, Germany, Belgium, and the Netherlands. If French air defense aircraft are added to this total, the U.S. contribution becomes less than one-fourth.

There are also differences in the sophistication of the aircraft that are contributed. For example, of the airborne radars now provided only by the United States and Great Britain, the U.S. contribution is more advanced. The British Royal Air Force currently employs Shackleton aircraft to perform radar surveillance of possible avenues of approach over the North and Norwegian Seas, and is procuring Nimrod jet aircraft to replace the propeller-driven Shackletons. Because of the limited capabilities of the Nimrod's radar, however, it only functions efficiently over water. In contrast, the U.S. E-3A Airborne Warning and Control System (AWACS) aircraft is advertised as having considerable "look-down" surveillance capability over land. In addition, the AWACS is supposed to provide a backup command post for tactical air battles.

As Table 1 suggests, U.S. air defense fighters are also generally more sophisticated than those of the NATO allies. Several NATO countries currently depend on American-designed aircraft--including the F-4 Phantom and F-104 Starfighter--as well as planes of national manufacture, but most of the latter are of earlier generations than the F-4s and F-15s provided by the United States.

The current gap between the more modern U.S. fighter assets in Europe and those of the NATO allies will close in the future as the fourth-generation F-16 fighters enter the inventories of the Belgian and Dutch air forces. This aircraft has a ground attack capability. In addition, it has excellent close-in, air-to-air combat potential and can be assigned an air defense mission. For this role, the F-16's armament consists of a 20 mm. cannon and infrared (heat-seeking) Sidewinder missiles. The F-16 lacks the ability to employ radar missiles and does not have the all-weather and beyond-visual-range capabilities that radar missiles imply. 2/ The F-16 is, however, considerably smaller

---

2/ The fact that the F-16 does not have radar missiles is not necessarily a drawback. In the chaos of European air battles following the initial attacks, visual recognition of aircraft would often be required. This is one reason why it is not advisable for every NATO fighter to have a beyond-visual-range capability. Another reason is that fighters with radar missile capabilities (like the F-15) are considerably more expensive than visual-range fighters (like the F-16) but may not get to exercise fully these capabilities because of problems in identifying friendly and enemy aircraft.

TABLE 1. COMPARISON OF NATO'S CURRENT AND FUTURE AIR DEFENSE FIGHTER AIRCRAFT, BY GENERATION a/

Country	Second Generation	Third Generation			Fourth Generation
		Early	Middle	Late	
United States		F-4E b/			F-15 b/ F-16 c/
Great Britain	Lightning	Phantom FG1, FGR2 b/, d/		Tornado ADV b/, c/	
France	Mirage IIIC		Mirage F-1 b/		Mirage 2000 b/, c/
Federal Republic of Germany		F-4F			
Belgium	F-104				F-16 c/
Denmark	F-104				F-16 c/
The Netherlands	F-104				F-16 c/

a/ "Generation" is a crude way of expressing levels of sophistication and/or the age of a particular aircraft design. It is not necessarily a good measure of capability; historically, more "sophisticated" systems have often been proven to be inferior to simpler ones in combat.

b/ These aircraft carry avionics permitting them to employ radar missiles, which can engage targets at night or in bad weather and beyond visual range. Problems with current identification of friend-or-foe (IFF) systems, however, mean that this capability may be of limited value in wartime. IFF problems may necessitate reestablishment of visual identification rules-of-engagement to avoid shooting down friendly aircraft.

c/ These aircraft types are planned acquisitions that have not yet joined the force. The only plane that may not do so is the Tornado ADV; its high development costs will be difficult to amortize over the planned production run of 165 aircraft.

d/ This aircraft is similar to the U.S. Phantom, but is equipped with different engines.

than the F-4 and the new U.S. F-15 air superiority fighter, and small size is a distinct advantage in air-to-air combat.

The West German Air Force has already procured most (if not all) of the 86 F-4F Phantom aircraft that will comprise its air defense fighter force until the 1990s. 3/ There are plans, however, to enhance the capabilities of this force by modifying the planes to permit use of the AIM-9L Sidewinder missile. (This is a more recent version of the infrared Sidewinder 1B missile currently in service with German F-4s.) At present, there are no plans to adapt the German F-4 to take a radar missile such as the U.S. Sparrow.

The British Royal Air Force also plans to modernize its air defense fighter force. Its choice for this purpose is an air defense variant (ADV) of the multinationally developed Tornado aircraft. This aircraft will be armed with both Skyflash (a radar missile) and Sidewinder. The British reportedly plan to buy 165 of the Tornado ADV, and some of these planes may be available for defense of the Central Region.

Thus, in the early 1980s, the air defense fighters of NATO's members may show somewhat less variation in sophistication, generation, and type than is now the case. And, overall, NATO's air defense fighter assets will be even more formidable than they are now. Both the U.S. F-15 and the British Tornado ADV will reportedly have radars that can pick out low-flying aircraft from the clutter of radar returns from the ground and then guide missiles to destroy them. While no missile presently deployed with NATO is sufficiently effective for the "look-down/shoot-down" role, such a missile may be available for U.S. aircraft in the 1980s. 4/ NATO air defenses could also be greatly enhanced if arrangements were made to use U.S. fighter and attack aircraft

---

3/ CBO estimate based on information about aircraft procurement and assignment given in "World Air Forces 1977," Flight International (July 2, 1977), p. 45.

4/ The United States is developing an "advanced monopulse seeker" to enable a future version of the AIM-7 Sparrow missile to be used in such a role with the F-15. (The British claim that their Skyflash missile is effective in the look-down/shoot-down mode; some U.S. specialists are skeptical of this claim, however.)

24-769 O - 78 - 5

from Navy carriers in overhaul and from Marine wings not engaged in combat as part of a division-wing team. The fighters could, for example, provide air defense directly, while the attack aircraft could free the multipurpose F-16s for air defense missions. The use of U.S. Navy and Marine air assets would probably require the prepositioning of equipment near existing European airfields but, if accomplished, could add dramatically to NATO's overall fighter capabilities.

Despite the changes described above, there will continue to be differences among allied contributions. The United States is likely to be the only contributor of something like the F-15--a highly sophisticated, expensive aircraft designed specifically for an air superiority role. In terms of numbers, the United States will continue to contribute roughly one-quarter to one-third of NATO's air defense fighters during peacetime and more than one-half in the event of a conflict.

GROUND-BASED AIR DEFENSE SYSTEMS

In making decisions about air defense procurement, the Congress should be mindful of the differences between U.S. and allied ground-based systems. As noted above, such differences may imply weaknesses in particular sectors. Weaknesses in particular sectors can contribute to weaknesses in alliance air defenses elsewhere. In addition, some of the allies' choices regarding ground-based systems suggest alternatives--like large numbers of AA guns--that the United States could consider choosing as well.

In discussing ground-based systems, it is convenient to distinguish between long- and short-range systems. The U.S. forces in Europe and most of their NATO allies have committed themselves to the same kind of long-range ground-based air defense systems but employ some of them differently. In terms of short-range ground-based systems, however, the variations between the United States and its NATO allies stem more from the different weapons each nation emphasizes than from doctrine or the manner in which weapons are used. These differences will remain if present procurement plans are not changed, although there will be greater standardization among NATO members with respect to particular short-range systems.

Long-Range Systems

This designation actually covers two different kinds of systems: ground-based radars and medium-to-high and low-to-medium altitude SAMs. 5/

The mainstay of the medium-to-high altitude SAM network in Germany is the Nike-Hercules missile. This missile can intercept aircraft as high as 100,000 feet and has a range of 140 kilometers (km.). Nike-Hercules units are presently in operation with the Belgian, German, and Dutch Air Forces and with the U.S. Army. 6/ Official observers believe Nike-Hercules has serious shortcomings.

The Hawk missile defends against invading aircraft and operates from the point where it is masked by ground clutter (the "radar horizon") up to around 50,000 feet. It is more mobile than Nike-Hercules and has a range of around 40 km. Hawk is presently deployed in two versions, Basic and Improved. Most of the NATO countries that deploy this system are moving toward the Improved version.

There are differences, however, in how Hawk is used in Europe. One possible inadequacy, noted earlier, is that Hawk is typically not deployed in depth in the northern part of the Central Region. According to Senators Sam Nunn and Dewey Bartlett, another problem is a shortage of reload supplies of U.S. Hawk missiles. 7/ If American forces are short of adequate reload

---

5/ Since the radars are not important to the discussion of options in the next chapter, information on them is contained in Appendix A.

6/ The British contribution to SAM deployments in northern Germany is the Bloodhound missile, an older, radar-guided SAM with longer range than that of the Hawk. This system is not discussed in the text because it is to be withdrawn in the near future; in addition, it is used for airbase defense, rather than in the allies' SAM belt.

7/ NATO and the New Soviet Threat, Report of Senator Sam Nunn and Senator Dewey F. Bartlett to the Senate Committee on Armed Services, 95:1 (January 24, 1977), p. 15.

supplies, the Europeans are likely to be short as well. This would be consistent with allied policies on the size of stocks of ammunition of other kinds.

The Army wants to remedy present flaws in Hercules and Hawk deployments by replacing both systems with the very expensive Patriot missile. The principal mission of this system, like that of Nike-Hercules, is denying Pact aircraft the option of operating at medium and high altitudes. The Patriot, however, is supposed to be capable of intercepting aircraft at low altitudes as well.

Patriot's potential contribution to overall alliance air defense capability depends on whether it can perform as claimed and on how it is deployed. Two issues are important with respect to its deployment. One is whether nations that procure Patriot choose to use it for their entire long-range SAM system or rather to undertake a partial deployment of Patriot, replacing Nike-Hercules but leaving Improved Hawk missiles in place. The other issue is whether the allies (and especially the Germans) decide to deploy Patriot at all.

If only the United States procures Patriot, air defense over the U.S. sectors should be stronger than before. This could mean that air defense fighters that would otherwise be allocated to the U.S. sector might be free to protect allies' sectors.

Short-Range Air Defense (SHORAD) Systems

SHORAD systems discussed here have maximum effective ranges between one and seven kilometers. A variety of such systems are deployed in the Central Region. An overview of SHORAD weapons, which is provided below, is important to understanding the mixes of systems proposed as options in Chapter IV.

Anti-Aircraft (AA) Guns. Allied armed forces rely on AA guns to a greater extent than does the United States. 8/ This fact is important because large numbers of AA guns can make a tremendous

---

8/ The Germans, for example, have almost 3,000 such guns, or roughly one gun for every 115 personnel in their army during peacetime. The United States has around 100 anti-aircraft guns in the Central Region, or only about one gun for every 2,000 U.S. Army troops stationed there.

contribution to the defense of ground assets, especially when deployed in conjunction with SAM systems like Hawk. These guns need not destroy enemy aircraft to make such a contribution. By simply forcing Pact pilots to fly higher and faster, and distracting them in the performance of their missions, AA guns can significantly reduce the effectiveness of enemy air power. Nevertheless, large numbers of guns were the principal means by which high-performance aircraft were shot down in recent wars. 9/

There are significant differences between U.S. and allied AA guns currently deployed in Europe, aside from the inadequate numbers of U.S. systems. The standard U.S. system is the Vulcan 20 mm. cannon, a visually guided, self-propelled AA gun that is supposed to protect combat units near the front. The Vulcan is a poor system to use in this role because of its lightly armored chassis, unsatisfactory fire control system, and poor capacity to engage Pact attack helicopters. By contrast, the allies deploy a wide variety of anti-aircraft guns that seem to be of better quality overall. Those that are self-propelled frequently have better armored mounts.

Short-Range SAMs. Two kinds of short-range SAMs are now in the inventories of NATO countries. Several countries deploy shoulder-fired SAMs: the United States and West Germany use the U.S.-designed, infrared Redeye missile, while Great Britain and Canada use the British-designed, radio command-guided Blowpipe. The United States intends to use Redeye for defense of maneuver and fire-support units; the allies probably intend to use these systems in the same way. Vehicle-launched SAMs are also deployed. The United States uses the infrared Chaparral; the British deploy the radar-guided Rapier; and the French possess the radar-guided Roland.

9/ AA guns accounted for 83 percent of the 919 aircraft shot down over North Vietnam between August 4, 1964 and October 29, 1969. Similarly, "the great majority" of Israeli aircraft losses during the Yom Kippur War were caused by the Soviet-designed ZSU 23-4 self-propelled AA gun. The presence of SAMs contributed to these losses, since planes sometimes flew within gun range in order to avoid SAMs. (See "The Vulnerability of the Manned Airborne Weapon System," International Defense Review, No. 6 (1977), p. 1066; "Evolution in Air Defense Requirements," International Defense Review, No. 3 (1974), p. 313.)

Planned Changes in SHORAD Systems. In the future, some of the current diversity in approaches to short-range air defense and in the systems used will probably be eliminated. Both the United States and its allies intend to procure different versions of a new 35 mm. all-weather gun. 10/ These guns are to be mounted on a tank chassis to permit them to be used at the front. Thus, although U.S. and allied gun deployments may remain different overall, they will increasingly rely on some standard systems.

The United States and its allies are also moving toward use of standardized short-range SAMS. 11/ Like most other infrared missiles currently deployed, the U.S. Chaparral is not useful in conditions of low visibility or bad weather. Consequently, the United States plans to procure a radar-guided, short-range SAM called Roland that is also entering the inventories of the French and German armies. Present Defense Department plans call for deploying the Roland in rear areas only; the U.S. Army wants to

---

10/ The 35 mm. cannon and its ammunition reportedly comprise a highly effective AA weapon. In view of the poor all-weather capability of the Warsaw Pact air forces, however, the decision to buy these guns instead of a simpler 35 mm. self-propelled AA gun system is questionable. At a unit cost of around $3 million, these guns are extremely expensive. Roughly half of this cost is due to a radar-aiming system required for the gun's low-visibility/all-weather capability. Since, for some time to come, Pact jet aircraft of the types presently deployed are unlikely to pose much of a threat to front-line units in bad weather, the view that NATO forces need an all-weather gun for defense against such aircraft is debatable. Indeed, it may be that NATO should emphasize clear-weather systems, since they are cheap enough to deploy in large numbers and since Pact air forces are most capable of effectively attacking ground forces in clear weather.

11/ Two possible exceptions to this generalization arise from the fact that the United States is developing a replacement, called Stinger, for the Redeye shoulder-fired SAM and is phasing in an improved version of the Chaparral vehicle-launched SAM. The Germans presently deploy Redeye; whether they will replace it with Stinger remains to be seen. There is no indication that any Central Region allies intend to procure the "Improved Chaparral."

increase the number of systems procured in order to deploy some Roland launchers closer to the front. If adopted, the Army's plan would double the cost of procuring the Roland system.

CONCLUSIONS

The analysis in this chapter leads to two conclusions regarding the Central Region's air defense. First, there appears to be a convergence by NATO members on some of the weapons each contributes to the alliance's air defense and on the manner in which they are employed. This is particularly noticeable in the case of fighters. Some variations will remain, but NATO's fighter force in the 1980s will probably be more uniform in sophistication and capability than it is today. This is also true of certain categories of SHORAD systems.

Second, the planned changes in U.S. and allied systems mean that NATO is getting stronger, and this strength, to an extent, simplifies the problem of providing air defense for the Central Region. Improved deployments of ground-based systems will enhance the defenses of particular sectors; fighters hedge against the possibility that ground-based air defenses in northern Germany would prove inadequate in the face of a Pact air attack; and AWACS, COBs, and shelters should enhance fighters' efficiency.

Unfortunately, the conclusions just stated do not bear clear-cut implications for Congressional choices regarding air defense. The Congress must, however, decide to buy some combination of type and quantity of air defense systems this year. Of course, any of an infinite number of such combinations could be chosen. To make this decision more manageable, it is important to have some framework for choice. The following chapter proposes such a framework.

CHAPTER IV. OPTIONS

Although this paper primarily addresses U.S. air defense procurement issues, it has discussed the allies' air defense systems and plans in considerable detail. This emphasis follows from the facts that U.S. air defense systems are primarily intended to enhance U.S. capability to defend the Central Region and that this defense is accomplished in conjunction with other NATO countries. For these reasons, Congressional decisions about which systems to buy depend in large part on how the Congress wants to structure the overall role that the United States will play in NATO. Accordingly, the roles currently played by the United States provide a useful framework for structuring choices regarding the procurement of air defense weapons systems.

The United States now plays three distinct roles in defense of the Central Region. Like several other NATO countries, the United States is assigned specific sectors of the front to defend and deploys ground forces and necessary support in order to perform this mission. As noted earlier, the U.S. sectors are located in southern Germany, which is not thought to be the most likely avenue of a Warsaw Pact attack.

The United States is also committed to augmenting the defenses of northern Germany with aircraft, should the need arise. This role necessarily results from the facts that the United States would contribute a large number of aircraft in time of war and that these planes would be under the command of Allied Air Forces Central Europe.

Finally, the United States is committed to reinforcing NATO with additional ground forces. These forces would be sent to bolster that part of the Central Region where the threat was greatest in time of war. Thus, it is likely that they would be sent to northern Germany.

The budget options specified below each represent air defense procurement consistent with fulfilling one of the roles described above. Each option is summarized in Table 2.

TABLE 2. COMPARISON OF OPTIONS

System	Current Defense Department Program
F-15	6 wings
F-16	12 wings
Collocated Operating Bases (COBs)	The number completed and the rate of establishment are classified.
Roland, Stinger, Improved Chaparral, and Sparrow with Advanced Monopulse Seeker	Continued development and initial procurement
Patriot	Continued development and initial procurement
Anti-Aircraft Guns	Possible interim buy of 171 German 35 mm. radar-guided AA guns mounted on a tank chassis, followed by development and initial procurement of a more sophisticated U.S. version of an AA gun of the same type

(Continued)

a/ In 1983, the COBs program will still be incomplete and unable--despite the F-15 and F-16 cuts proposed here--to accommodate all U.S. Air Force fighters that could be employed in defense of the Central Region. Therefore, no cut in the COBs program is proposed here, despite the F-15/F-16 cuts.

TABLE 2. (CONTINUED)

Option I: Providing Aircraft to Augment Allied Defense	Option II: Providing Air Defenses for an Additional U.S. Corps	Option III: Modernizing Air Defenses for Smaller U.S. Ground Forces
6 wings	6 wings	5 wings
14 wings (or 12 wings plus facilities to permit the use of approximately 180 Navy/Marine aircraft)	13 wings (or 12 wings plus facilities to permit the use of approximately 90 Navy/Marine aircraft)	11 wings
Establishment of additional COBs or similar facilities at European civil airfields to accommodate two more F-16 wings or approximately 180 Navy/Marine aircraft	Same as Option I, but sized to accommodate one more F-16 wing or approximately 90 Navy/Marine aircraft.	Current program a/
Current program	Current program	Current program, with a decreased total buy, for savings after 1983
Current program but no procurement after 1983 b/	Same as Option I	Same as Option I
Purchase of 1,000 Rheinmetall 20 mm. guns, and development/procurement of a clear-weather 35 mm. gun, for savings against the Defense Department program after 1983	Same as Option I	Same as Option I

b/ Procurement of Patriot beyond fiscal year 1983 is not required if Hawk is retained and Patriot is deployed only to replace Nike-Hercules.

Two points should be noted about these options. First, the procurement proposals associated with them are not necessarily the most cost-effective. They are, however, good illustrations of the kinds of procurement decisions that would emphasize a particular U.S. role in NATO. Second, while several of the same types of air defense systems are proposed for each option, the quantities of the total programs change from option to option.

The rationale for the changes in airborne air defense will be described later, as each option is discussed. The rationale for the ground-based systems common to all options, however, can be conveniently explained here.

Each option is structured on the assumption of "partial" deployment of Patriot (that is, Patriot deployed only in replacement of Nike-Hercules, with Hawk retained). The rationale for this change in Defense Department plans would be cost savings. These savings do not show up, however, in CBO's cost estimates shown in Table 3. 1/

Continued procurement of Roland is incorporated in all three options. None of the options, however, provides for a program as large as the one that the Army has requested. 2/ Such procurement would seem advisable only if Pact air forces develop a more significant capability to attack U.S. combat units near the front in bad weather. If Pact air forces do develop such a capability, there will be adequate opportunity later for decisions to keep the Roland production line open.

1/ CBO's estimates of savings are based on changes from a baseline defined by projections of Defense Department spending over fiscal years 1979-1983. No savings show up as a result of buying the relatively small number of Patriot SAMs needed for a "partial" deployment in CBO's options, because the 1979-1983 projection provides for procurement of roughly the same number of missiles. In other words, savings from partial deployment would occur after fiscal year 1983, in years for which data are not available with which to make a savings estimate.

2/ As a result, acquisition of the Improved Chaparral is continued under all options, for use by active Army units. Such acquisition is consistent with current DoD policy that does not endorse the Army's request for additional Roland systems for use at the front.

TABLE 3. COSTS OF OPTIONS IN COMPARISON TO CURRENT AIR DEFENSE PROCUREMENT: BY FISCAL YEAR, IN MILLIONS OF CURRENT DOLLARS

Option	1979	1980	1981	1982	1983
Current DoD Program	4,420	5,120	5,060	4,060	3,650
Option I: Providing Aircraft to Augment Allied Defenses					
With Additional F-16 Procurement	0	440	430	530	630
With Employment of Navy and Marine Air	30	30	35	20	25
Option II: Providing Air Defenses for an Additional U.S. Corps to Reinforce Allied Sectors					
With Additional F-16 Procurement	0	440	430	100	200
With Employment of Navy and Marine Air	30	15	20	5	5
Option III: Modernizing Air Defenses for Smaller U.S. Forces a/	0	-460	-1,160	-460	-520

NOTE: All three options include $109 million to cover procurement of 1,000 Rheinmetall AA guns with ammunition for use in Europe. This sum is not included in the figures above.

a/ The savings displayed in this option result from the cut of one wing of F-15s and one wing of F-16s in comparison to present DoD plans, described on pp. 34-35. The deletion of three Army divisions would result in savings on air defense systems that accompany such units. These savings would accrue after fiscal year 1983, however, and are not displayed in this table.

Two changes from official plans for AA gun procurement are part of all three options. These changes are motivated principally by the improved air defense that results from deployment of large numbers of guns. The first change involves the development and acquisition of a relatively simple, visually-guided AA gun instead of the Army's proposed all-weather DIVAD (Division Air Defense) gun for use with U.S. forces at the front. An additional rationale for this change is that Pact jets do not now seriously threaten such units in low-visibility conditions and seem unlikely to do so in the foreseeable future. The option of acquiring more Roland systems already represents one way to hedge against unexpectedly swift Pact progress in low visibility/all-weather ground attack capability. In clear weather, however, Pact jets can attack such units, and they are likely to become increasingly capable of doing so. In addition, there is reason to believe that visually-guided AA guns can effectively engage Pact attack helicopters. These considerations make investment in larger numbers of a simpler gun seem a more appropriate means of enhancing the air defenses of U.S. ground forces near the front.

The second change from official plans is acquisition of the Rheinmetall 20 mm. AA gun that recently entered service with the German and Norwegian armies. At a unit cost of roughly $74,000, this weapon is extremely cheap and can be acquired in relatively large numbers. The Vietnam and Yom Kippur wars demonstrated the effectiveness of deploying a large number of guns in conjunction with SAM systems. Thus, large numbers of this gun would complement present U.S. Hawk SAM deployments in a way that fewer DIVAD guns could not. Finally, acquisition of the gun would constitute an instance of U.S. acquisition of systems produced by our allies to match their purchases of U.S. systems (the "two-way street" in weapons acquisition) and a step toward NATO standardization overall. For illustrative purposes, a buy of 1,000 guns is included in each option discussed below.

OPTION I. PROVIDING AIRCRAFT TO AUGMENT ALLIED DEFENSES

The Congress may decide that the United States should enhance its capabilities to offset possible weaknesses of allied forces in northern Germany. It may wish to do this, however, without a visible and dramatic increase in the U.S. role in NATO. If so, a reasonable policy to consider is one that would change current Defense Department plans in order to provide additional aircraft for NATO. Because of their mobility and inherent flexibility, they could help the United States or its allies, depending on where the greatest needs materialized.

If the Congress chose to provide additional air defense aircraft, these planes would have two important functions to perform. One would be defense of the A-10. (The Firepower and Overview papers in this series suggest provision of two wings of the A-10, a specialized ground-attack aircraft, in addition to the aircraft already proposed by the Department of Defense as a means of enhancing NATO firepower capabilities in northern Germany. Since the A-10 is expected to be very effective against Pact armor and will probably threaten Pact ground-based air defense systems at the front as well, Pact fighters might be used against the A-10. Therefore, adding A-10s to the force could possibly create an additional demand on NATO fighter resources.) Another mission would be coverage of the allies' rear areas to make up for the lack of in-depth Hawk SAMs. 3/

The missions just described can be performed in either of two ways. If only Air Force assets were used, two additional F-16 wings might do the job. 4/ Alternatively, arrangements could be

---

3/ Of course, the F-16s would not be a perfect replacement. Fighters and SAMs have different capabilities, and one can substitute only imperfectly for the other.

4/ The F-16 is proposed here rather than the F-15 because it is considerably cheaper. This is important for two reasons. First, two wings of F-16s can be procured for roughly the same cost as one wing of F-15s. This is important because the rationale for additional aircraft in this option involves their capability to perform missions at widely separated points over the Central Region. (One multipurpose F-15 might be as good or better than two F-16s, but it cannot fly over both the front and the allies' rear areas at the same time.) Second, the F-15's potential advantage over the F-16 associated with the F-15's radar missile capability might not be realized in a European war. Such missiles may not be usable in Central Region air battles after the initial wave of Pact air attacks because enemy and friendly aircraft would be intermingled in Central Region airspace. In such circumstances, the inadequacy of currently available electronic means for identification of friend or foe (IFF) might well mean that visual rules of engagement would be imposed. Such rules might reduce the potential of the F-15 so much that it would be hard to justify buying F-15s rather than the less costly F-16 as a means of enlarging U.S. fighter inventories.

made to bring fighters and attack aircraft into the Central Region from two Navy air wings associated with carriers in overhaul and one Marine wing from a division-wing team not engaged in combat. Navy and Marine aircraft could enhance A-10 protection and defend the allies' rear areas directly through provision of nearly 100 F-14 and F-4 interceptors employed in an air defense role. The ground-attack aircraft might indirectly enhance air defense by freeing U.S. and allied multipurpose F-16s to perform air defense missions and by tying down Pact air-to-air fighters that might otherwise be free to attack A-10s. These arrangements would involve developing additional collocated operating bases and prepositioning some materiel needed for wartime operations at those bases.

It is possible that a proposal to augment Central Region air defenses by preparing to use Navy and Marine aircraft would encounter resistance from these services. (Naval doctrine calls for operation from carriers; Marine doctrine envisions Marine aircraft being used in support of Marine ground units.) As a result, this option is costed on the assumption that two additional wings of F-16s are procured. It should be noted, however, that such a purchase involves $1.9 billion in procurement and operating costs that would be saved if provisions were made for Navy and Marine aircraft to operate in Europe. In other words, this option would add roughly $2 billion to currently planned air defense investment if additional F-16s were procured, but would add only $140 million if Navy and Marine assets were used instead.

This option (and the others) includes continued development of the AIM-7F Sparrow missile with Advanced Monopulse Seeker. This missile holds open the possibility that the look-down/shoot-down potential of the F-15 radar might be realized. If so, the F-15s that are procured will represent a more substantial hedge against Pact aircraft that attempt low-flying penetration and are able to evade other defenses.

Although NATO AWACS is a flexible airborne asset, it is not included in this option. For reasons outlined on pp. 56-57, this program does not seem critical to effective defense of the Central Region. If the Congress wishes to enhance NATO air defense capabilities on the flanks, it may want to consider NATO AWACS. Such enhancements, however, are not the focus of this option.

OPTION II. PROVIDING AIR DEFENSES FOR AN ADDITIONAL U.S. CORPS TO REINFORCE ALLIED SECTORS

The Overview paper in this series stated that U.S. capabilities to reinforce the allies in northern Germany could be enhanced by changing Defense Department procurement plans so as to permit prepositioning of materiel for a U.S. Army corps there. Such an enhancement would have two important consequences for air defense system requirements.

The first consequence would be the enhanced ground-based air defense that would follow from deployment of the SHORAD assets of three divisions and a supporting corps organization. Even if the United States chose not to procure more clear-weather AA guns and proceeded with current plans to procure a smaller number of expensive all-weather guns, the number of self-propelled AA guns in northern Germany would be sharply increased. The number of short-range SAMs would be increased even more sharply because the allies do not rely on such systems to the same extent that U.S. forces do. As a result of these changes, the effectiveness and survivability of Pact attacking aircraft could be significantly reduced.

The second consequence would probably be even more significant. A U.S. corps in northern Germany would greatly enhance NATO's ground-based firepower capabilities. As a result, fewer A-10s would be needed to reinforce northern Germany under this option. 5/ Fewer F-16s would therefore be needed to defend the A-10. Accordingly, this option would cut one wing of F-16s from the number proposed in Option I. One wing would remain, on grounds that inserting a U.S. corps would not offset the lack of in-depth Hawks.

Again, procurement of an additional wing of F-16s would not be required if Navy and/or Marine assets were used instead. Procurement of even one F-16 wing is a much more expensive way to enhance U.S. capabilities to defend northern Germany with fighters.

5/ For a fuller discussion of this issue, see Congressional Budget Office, U.S. Air and Ground Conventional Forces for NATO: Overview, Budget Issue Paper (January 1978) and the companion background paper, Firepower Issues.

The costs of this option are shown in Table 3. Procuring and operating an additional F-16 wing would cost approximately $1.17 billion; the alternative course of providing facilities to permit use of Navy and Marine aircraft in the Central Region would cost roughly $75 million. The costs of the ground-based air defense systems that would be prepositioned with the other equipment for a U.S. corps in northern Germany are not shown in Table 3 because the proposals made in this option do not imply cost changes in current Defense Department plans for air defense investment through fiscal year 1983.

OPTION III. MODERNIZING AIR DEFENSES FOR SMALLER U.S. NATO FORCES

The Congress may, for a number of reasons, wish to reverse the trends toward increased spending on U.S. forces for NATO and an increased U.S. role in the alliance. 6/ One means toward this end would involve deletion of three divisions that have been added to Army ground forces since fiscal year 1974 but continued modernization of the equipment used by the other 13 divisions in the Army. This policy would amount to a decision to emphasize the third role of U.S. forces in NATO: defense of the U.S. sectors in southern Germany.

Under this option, current Air Force procurement plans would be changed considerably. Part of the rationale for this change involves uncertainties already noted: it is not known where a Pact attack would occur, and it is not clear whether allied air defenses in northern Germany are in fact stronger than those in U.S. sectors to the south. Another part of the rationale involves the present place of U.S. air defense fighters in the organization of AAFCE. 7/ In wartime, these fighters would be sent by the Commander of AAFCE to wherever he saw the greatest need. Taken together, these considerations suggest that acquisition of the Defense Department's planned number of fighters would as likely be a means of strengthening the allies as a means of defending the U.S. sectors. Therefore, the Congress may not wish to emphasize procurement of fighters if it intends to restrict

---

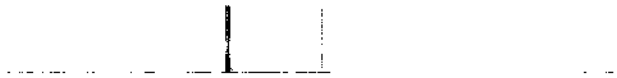
6/ For a discussion of possible rationales for this decision, see Congressional Budget Office, U.S. Air and Ground Conventional Forces for NATO: Overview, p. 39.

7/ Allied Air Forces Central Europe, defined in Chapter II.

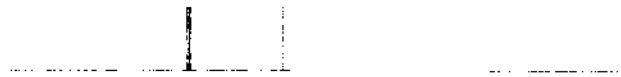
improvements in NATO to ones that would enhance the defense of U.S. sectors. In that case, resources might be directed to procurement of ground-based systems instead. For illustrative purposes, this option would reduce the purchase of F-15s and F-16s by one wing each. 8/

The ground-based air defense systems that were described at the beginning of this chapter are all included in this option. Modernization of the equipment of only 13 divisions is involved here, however, because smaller total programs for AA guns and the Improved Chaparral and Stinger SAMs would be required by Option III. This means that savings would be realized after fiscal year 1983, since production lines for these items could be shut down sooner. Savings will not show up before then, however, because the production projected in the 1979-1983 Five-Year Defense Plan is necessary for modernization of air defense systems for both a 13-division and 16-division force. Consequently, the savings associated with this option over the next five fiscal years would result from the aircraft reductions described above, for a total savings of $2.6 billion.

8/ No accompanying cuts in the collocated operating base program are proposed here, for reasons outlined in the footnote to Table 2, p. 26.



APPENDIXES



APPENDIX A. U.S. AND ALLIED AIR DEFENSE PROGRAMS

This appendix provides background information and supporting detail not included in the body of the paper. It organizes the discussion of U.S. and allied air defense programs somewhat differently from the text. Two headings below are familiar: the section on "Ground-Based Systems" describes long-range surface-to-air missiles (SAMs) and short-range air defense (SHORAD) systems; and the section on " Airborne and Airborne-Related Systems" discusses the shelter and collocated operating bases (COBs) programs, the possibility of using Navy and Marine aircraft in Europe, and certain aspects of U.S. and allied fighter forces. The section on "Central Region Early Warning Systems," however, includes both ground-based and airborne radars.

GROUND-BASED SYSTEMS

Short-Range Air Defense Systems

Currently deployed U.S. and allied SHORAD systems are listed in Tables A-1 and A-2. Since the significance of some of the characteristics listed in Table A-2 is not obvious, they are discussed below.

Desirable characteristics in a SHORAD system include:

- Ability to hit maneuvering, multiple targets that are using jamming devices.
- Integral IFF Capability. This is a means of automatic identification of friend or foe (IFF). A reliable IFF capability would permit friendly aircraft to operate more freely in support of ground troops and would permit air defense systems to engage targets without waiting for visual identification. 1/

1/ A truly secure and reliable IFF system is apparently not operational with NATO forces. For a more detailed discussion of such devices, see Julian S. Lake, "Is That You, Charlie?" Military Electronics/Countermeasures (December/January 1977/78).

TABLE A-1. CURRENTLY DEPLOYED SHORAD SYSTEMS a/

System (Nation of Origin)	System Type (Range) b/	Assigned Mission c/
Redeye (United States)	Short-range SAM (3 km.)	U.S.--self-defense for front-line units, artillery units, and Chaparral/Vulcan units; allies--probably similar.
Blowpipe (Great Britain)	Short-range SAM (unavailable)	Probably similar to Redeye; certainly infantry self-defense.
Chaparral (United States)	Short-range SAM (5 km.)	Defense of relatively static high-value targets in rear areas.
Roland (France/ Federal Republic of Germany)	Short-range SAM (6 km.)	French and German--defense of combat elements near the front; U.S.--defense of rear areas, perhaps areas nearer the front as well.
Rapier (Great Britain)	Short-range SAM (5+ km.)	Airbase defense and probably defense of high-value rear area assets.
Bofors L/70 (Sweden), Rheinmetall Rh-202 (Federal Republic of Germany), or similar 20 mm. to 40 mm. gun	Short-range gun (3 km.)	Probably defense of high-value targets in rear areas.
Vulcan (United States)	Short-range gun (2 km.)	Defense of combat units in mobile operations at the front; defense of static high-value targets in rear areas.
Oerlikon KCB (Switzerland)	Short-range gun (3 km.)	Probably defense of maneuver units.

(Continued)

a/ This table is not exhaustive, but does describe the most important SHORAD systems now deployed by NATO countries.

b/ Sources for range systems: Bofors L/70, Redeye, and Rapier ("Evolution in Air Defense Requirements," International Defense Review, No. 3 (1978), pp. 313, 316); Chaparral and Vulcan (U.S. Army Air Defense Artillery Employment (Field Manual 44-1, 1976), p. 3-1).

TABLE A-1. (CONTINUED)

Forces Deploying	Means of Mobility	Target Detection	System Guidance
United States, Federal Republic of Germany	Manpack	Visual	Infrared
Great Britain, Canada	Manpack	Visual	Radio command, with optical tracking
United States	Lightly armored tracked vehicle	Visual, but Chaparral can operate with a forward-area alerting radar (FAAR)	Infrared
France currently; in the future, United States and Federal Republic of Germany	French--tank chassis; German--armored fighting vehicle chassis; U.S.--wheeled vehicle if procured for rear areas only, otherwise tracked chassis	Visual in daylight/clear-weather version; radar in low visibility	Radar
Great Britain	Towed	Visual or radar	Visual or radar
Great Britain, Canada, France, Federal Republic of Germany, the Netherlands	Towed	Visual or radar	Visual, some models with laser range-finders
United States, Belgium	Lightly armored tracked vehicle; towed version with airborne units	Visual	Visual (range-finding radar only)
France (and perhaps Great Britain)	Self-propelled. French--on light tank chassis; British gun--on tracked armored fighting vehicle mount	French--radar; British--visual	French--radar; British--visual

c/ Entries pertaining to allied missions are not necessarily official doctrine; in many cases, they represent a CBO estimate based on available evidence.

TABLE A-2. PERFORMANCE CHARACTERISTICS OF CURRENTLY DEPLOYED SHORAD SYSTEMS

System (Nation of Origin)	Reported IFF Capability	Judgmental Estimates of Performance at the Front		
		Dual Capability	Survivability	Ability to Defeat Pact Helicopters
Redeye (United States)	No	No	Fair	Fair
Blowpipe (Great Britain)	Yes	No	Fair	Fair
Chaparral (United States)	No	No	Poor	Fair
Roland (France/ Federal Republic of Germany)	N/A a/	No	Fair	Fair
Rapier (Great Britain)	Yes	No	Poor	Fair
Bofors L/70 (Sweden), Rheinmetall Rh-202 (Federal Republic of Germany), or similar 20 mm. to 40 mm. gun	No	Yes	Poor	Good
Vulcan (United States)	No	Yes	Fair to Poor	Fair (range limitations)
Oerlikon KCB (Switzerland)	No	Yes	Fair (British) Good (French)	Very Good

a/ Not available.

- Dual Capability. This is the ability to engage both ground and aerial targets. It is primarily characteristic of anti-aircraft (AA) guns and is desirable because AA weapons might be employed against enemy aircraft for only a small proportion of their time in combat. For the rest of the time, AA weapons without dual capability would be a burden rather than an asset to combat units.

- Survivability. Assessing this attribute is a matter of rough judgment, based on a system's mobility, armor protection, dual capability, and size (hence, its ability to hide and/or use terrain for protection from enemy fire).

- Ability to Defeat Pact Helicopters. This is important because attack helicopters are reported to be a serious threat to NATO units at the front. Here again, assessment is a matter of judgment, based in part on a system's mobility and range.

The last three characteristics are primarily relevant to performance at the front. Many SHORAD systems, however, are not now intended for use there, in part because they are unlikely to survive in that environment. They are also needed to provide low-altitude air defense coverage in critical areas behind the front. High-value targets such as airfields and nuclear weapons storage sites are examples of such critical areas; additional systems are placed around them to engage aircraft that could evade SAMs and fighters. Another example of a high-value target is the area around a SAM site--termed its "dead zone"--in which the SAM cannot destroy enemy aircraft. 2/ Short-range SAMs (or guns) are needed to cover this area in order to protect the long-range SAMs and thus the security of whatever else is being protected.

SHORAD systems currently deployed with active U.S. forces have several shortcomings. Redeye, a man-portable, infrared SAM, lacks IFF. It also has problems in engaging jets because of their their high speed and maneuverability and because of Redeye's small warhead. Chaparral, a vehicle-launched, infrared SAM, is more lethal. Its relatively light armor, however, makes it less likely

---

2/ This "dead zone" is characteristic of all SAMs. It exists for various technical reasons.

to survive in action near the front. In addition, the optical-aiming feature of both Chaparral and Redeye limits their usefulness at night and in bad weather. 3/ Vulcan, a visually guided anti-aircraft gun mounted on a tracked chassis, is also lightly armored. Its fire control system is unsatisfactory, making it difficult to hit high-speed airborne targets. In addition, there is reason to believe that Vulcan would do poorly in protecting U.S. tanks against Pact attack helicopters that might launch antitank missiles while beyond the Vulcan's effective range. 4/

Proposed Changes in U.S. and Allied SHORAD Systems. As noted in the text, the United States and its allies are moving toward greater standardization with respect to certain categories of SAMs and AA guns.

The Dutch, Belgian, and German armies are planning to buy a version of a newly developed 35 mm. self-propelled anti-aircraft gun. Its primary mission will be the defense of combat units along the front, 5/ but it may also be used for air defense in Belgium. 6/

The German and Belgian version of this gun, known as Gepard or Flakpanzer, is mounted on the chassis of the German Leopard

---

3/ Pact air forces have greatly reduced capabilities under such conditions. Appendix B describes why the Pact's relatively scarce all-weather ground attack aircraft are more likely to be used against rear-area targets than against targets near the front. Thus, Chaparral/Redeye's optical-aiming feature is only a shortcoming when employed to protect rear-area targets that are likely to be attacked at night or in bad weather.

4/ The Mi-24 Hind-A helicopter can carry four Swatter antitank guided missiles. The Swatter is reported to have a range of 2,500 meters. (See "An Analysis of Soviet Artillery Development," International Defense Review, No. 6 (1977), p. 1059.) By comparison, Army manuals report a range of 2,000 meters for Vulcan, against airborne targets.

5/ Jane's Weapons Systems, 1976, p. 97.

6/ "Germans Weighing Alternative Patriot Acquisition Techniques," Aviation Week and Space Technology (August 29, 1977), p. 48.

tank. It can be aimed optically or by radar. The radar system enables the Flakpanzer to be capable of all-weather operation. 7/ The German Army has ordered 450 Gepards, and the Belgians have ordered 55.

The Dutch version of the same system, known as Cheetah, is identical to Gepard except for the installation of a different radar. The Dutch Army has ordered 95 Cheetahs.

The U.S. Army has shown considerable interest in buying a fleet of 171 Flankpanzers. 8/ In addition, the Army is currently considering selection of the appropriate version of an all-weather AA gun system for use with ground troops near the front. (The system's acronym is DIVAD, for Division Air Defense).

The model and contractor for the DIVAD gun have not been selected, although the Army is committed to using the M-48 tank's chassis. As a result, it is difficult to be very precise about the system's cost. Projected data on yearly purchases, however, indicate a unit cost of between $3.3 million and $4.8 million.

The proposed DIVAD gun will be more capable than the existing Vulcan gun in several respects. It will have a longer range that will enable it to engage both jets and attack helicopters that threaten U.S. tanks. It will also have radar fire control, so that it can be used in low-visibility conditions. This requirement is a major reason for the extremely high cost of the gun. It is also supposed to be equipped with an integral IFF capability. Mounting the gun on the M-48 chassis will afford the crew greater protection for operations near the front and will permit the gun to keep up with tanks on the move in combat.

Alternatives to the DIVAD gun were discussed in the text. Most of the important features of these alternatives were stated there as well. It is important, however, to discuss a possible objection to the Rheinmetall Rh-202 20 mm. gun. This objection

---

7/ Radar also provides information on a target's range. A system employing range-only radar, however, would be considerably simpler than that of the Flakpanzer.

8/ "Pentagon Picks Firms to Develop Air Defense Gun," The Wall Street Journal (November 30, 1977), p. 4.

concerns the idea that deploying the Rh-202 gun in large numbers would imply large operating costs, since large numbers of personnel would be required. In fact, however, such personnel costs need not be incurred. The Rh-202 gun costs only about $74,000 per unit, so it is extremely inexpensive. In addition, it can be operated by one man. It would therefore seem reasonable to issue the Rh-202 gun to units whose personnel would operate it only during air raids, rather than on a full-time basis. For example, some members of Patriot units are presently slated to use Stinger SAMs to protect the Patriot against aircraft that are too close to be successfully engaged by the Patriot itself. These men could operate the Rh-202 instead. Large numbers of rear-area support troops--for example, those assigned to the Kaiserslauten logistics complex--could also be trained to use this weapon.

The second standardized SHORAD system that the United States and some allies intend to acquire is the Roland. This is a vehicle-launched, radar-guided SAM that reportedly possesses all-weather capability. Each nation employing Roland intends to mount the weapon on a different chassis. In addition, indirect evidence suggests that the U.S. system may be different from the French-German Roland in other important respects. The Roland missile is, however, supposed to be usable by all three nations' launchers.

An important difference between the U.S. Roland and that of the French and Germans involves its mission. The allies intend to use Roland in defense of combat elements near the front 9/; the U.S. Defense Department plans to use it for defense of high-value assets in rear areas, such as airbases. The U.S. Army has shown interest in using Roland nearer the front as well, to replace the Chaparral missile system. If approved, this additional role would nearly double the cost of the Roland system. 10/

The United States is making some other changes to its inventory of SHORAD systems that will not involve standardized weapons. These changes were noted briefly in the text and are worth discussing in more detail here.

9/ "Roland," International Defense Review, No. 2 (1975), p. 202.

10/ The principal reason for this increase in cost is that about twice as many firing vehicles and missiles would have to be procured.

One of these weapons is the Stinger. This is a man-portable, shoulder-fired SAM, designed as the successor to Redeye. Stinger is said to be more capable than Redeye; it can engage oncoming aircraft and is not limited to the "tail-chase" mode. Also, Stinger reportedly possesses an IFF capability.

The second weapon is the Improved Chaparral. This is a follow-on system to the Chaparral missile described in Table A-1. It has a newer infrared seeker and an improved warhead and fuse. The Improved Chaparral is also intended to have an IFF capability.

If Roland is deployed near the front lines as well as in rear areas, Improved Chaparral may be supplied to reserve units. If Roland is not deployed near the front, Improved Chaparral may be the standard SHORAD SAM for use there.

Long-Range SAMs

Most of the important information about these systems was covered in the text. Some other issues, however, merit brief discussion.

Hawk. It was noted in the text that most NATO countries that deploy Basic Hawks in the Central Region are moving toward deployment of the Improved version. Improved Hawk differs from Basic Hawk in several ways. It has an enhanced Electronic Counter Countermeasures (ECCM) capability and is claimed to be more reliable and easier to maintain. It also possesses an automatic data-processing unit that will be capable of handling difficult tasks that were formerly performed by operators.

Nike-Hercules. Two points about the Nike-Hercules are worth noting. First, it is capable of carrying a nuclear warhead. The putative advantage of this capability is that it would complicate the problem of planning a Pact air attack. (Mass aircraft formations are more vulnerable to nuclear warheads than to conventional ones. Therefore, possession of a nuclear Hercules might give pause to any Pact planner who was otherwise attracted to using such formations.) Many observers believe, however, that the Hercules' nuclear capability will not have this result because it is doubtful that the United States would use it.

Second, and quite apart from the merits or flaws of its nuclear capability, Nike-Hercules has serious shortcomings.

For example, Hercules is very limited in the number of threat aircraft it can track and engage. 11/ In addition, indirect evidence suggests that Hercules would do very poorly against aircraft that employed evasive maneuvers.

Patriot. It was noted in the text that the Patriot missile (formerly called SAM-D) is a very expensive replacement for both the Nike-Hercules and Improved Hawk missiles. This observation was based on the fact that its program cost in fiscal year 1979 is expected to be $295.7 million and its costs from fiscal year 1979 until completion will be about $4.8 billion. This compares with a total program cost of $1.6 billion for the Roland, the next most costly Army air defense procurement program.

Several points about Patriot's advertised capabilities are worth noting. It is designed to engage a number of targets simultaneously. Some observers claim that it will also be useful against highly maneuverable aircraft. 12/ According to the Army, a full deployment of Patriot will require less manpower than would be needed for the Nike-Hercules and Hawk SAMs that Patriot would replace. In addition, Patriot is reported to be able to "maintain its effectiveness despite intense electronic jamming." 13/

Two other characteristics of Patriot deserve mention. First, a Patriot firing platoon will be capable only of sector coverage. In other words, it will not be able to give itself 360-degree protection. 14/ For such all-aspect preparedness, a number of firing platoons would have to be deployed together.

A second characteristic of Patriot (and other SAMs) is its "dead zone." SAM radars are limited by terrain, and the missiles

---

11/ "Germans Weighing Alternative Patriot Acquisition Techniques," Aviation Week and Space Technology, p. 48.

12/ Jane's Weapons Systems, 1977, p. 86.

13/ Ibid.

14/ This limitation results from Patriot's otherwise technically impressive phased-array radar. Hawk's radar is in most respects inferior to Patriot's, but it does provide 360-degree coverage.

cannot engage targets at close range. Therefore, Patriot cannot protect itself against close-in threats. As a result, other SAMs or some type of gun will have to be deployed to protect Patriot. The Army intends to use Stinger for this purpose, and will man it with personnel assigned to the Patriot batteries.

AIRBORNE (AND AIRBORNE-RELATED) SYSTEMS

Aircraft Shelters

For several years, the United States has been engaged in a program of building hardened aircraft shelters to protect aircraft on the ground from enemy air attack. This program is very important, judging from recent experience in the Middle East. In the 1967 Middle East war, for example, the Israeli Air Force was able to destroy a large percentage of the Egyptian Air Force on the ground because the Egyptian aircraft were not sheltered. In contrast, the Arabs sheltered their planes in the 1973 war, and very few were knocked out on the ground.

The United States is eligible for NATO infrastructure funding for shelter construction for 70 percent of its aircraft based in Europe or committed to be transferred to Europe within a certain number of days after mobilization. The United States has already appropriated funds for construction of shelters, and it expects to be reimbursed for part of this expense by NATO. In fiscal year 1978, $60 million was appropriated for this purpose.

The United States has not, however, embarked on a shelter program for its Airborne Warning and Control System (AWACS) aircraft. This is hard to explain, since the AWACS will probably be based in England in time of war and Air Force authorities apparently believe that aircraft on the ground there are vulnerable to Soviet attack. (Shelters are being constructed in England for U.S. Air Force fighter-bombers.) In addition, at a unit cost of $77 million, the AWACS is an extremely expensive aircraft. Finally, the Air Force gives glowing accounts of the system's capabilities and of the contribution it might make to Central Region air defense. In view of these facts, it is unclear why the AWACS is not an intended candidate for sheltering.

Collocated Operating Bases

For several years, the United States has been negotiating with allied governments to establish collocated operating bases (COBs) in Europe. As noted in the text, COBs are allied airbases at which aircraft reinforcements from the United States would be stationed in time of war. The purpose of the COB program is to take advantage of excess capacity at allied airbases in order to permit dispersed basing of U.S. aircraft. (Dispersal is an important means of passive air defense for these planes.)

Establishment of a COB begins with an agreement between the United States and one of the allies. This is followed by construction of facilities that will be needed for U.S. planes to share the base--for example, aircraft shelters, ammunition and fuel storage facilities, and paved areas for taxiways and parking.

Under the terms of a COB agreement, allied forces can always use these facilities in peacetime and can use them in time of war until U.S. planes arrive. If an attack came with little or no warning, many aircraft normally based in the United States would not be in Europe at the beginning a war; hence, completed COB facilities would represent a significant enhancement of allied capabilities in this possibly critical period. At a minimum, they would complicate the task of Pact attackers. For example, if the allies had provided shelters for all their aircraft, Pact aircraft would likely attack some empty U.S. shelters, since Pact pilots would not know which shelters contained planes. If, on the other hand, allied air forces did not build enough shelters for their aircraft, then shelters that the United States built at COBs could protect allied planes. In addition, other facilities built by the United States could conceivably permit operation of the base even if enemy attack destroyed allied facilities of the same type.

Although the allies will benefit from the COB program, they do not directly contribute to construction costs or to operating costs in peacetime. 15/ As a result, accelerated U.S. funding

---

15/ Shelter construction is an exception to this generalization. As noted above, some of the shelters to be used by U.S. aircraft from the United States are eligible for NATO infrastructure funding to cover construction costs. The current infrastructure fund has, however, obligated nearly all its resources through 1979. A new fund must be negotiated before financial support is available from this quarter.

of COBs would both enhance allied passive air defenses and augment U.S. capabilities to offset allied weaknesses with aircraft.

Prepositioned Materials to Permit Use of Navy and Marine Aircraft

Navy and Marine tactical air forces possess impressive fighter and ground attack capabilities. Most of the Navy's aircraft are organized into multimission carrier air wings. A typical wing includes 24 F-4s/F-14s, 24 A-7s, and between 9 and 12 A-6s. 16/

The F-4 Phantom and the F-14 Tomcat are useful for air superiority and air intercept missions and have a ground-attack capability as well. The F-14, which is replacing the F-4, is a highly sophisticated interceptor that can track and fire long-range radar missiles at several enemy aircraft simultaneously. The A-7 Corsair II is a light attack aircraft optimized for visual strike and interdiction missions. The A-6 Intruder is a medium attack aircraft capable of all-weather operation.

The active air resources of the Marine Corps include more than 140 F-4s, more than 90 A-4s, and more than 60 A-6s. 17/ Marine F-4s and A-6s are similar to Navy aircraft of this type; Marine A-4s are small, fast, and highly maneuverable light attack aircraft.

All of these aircraft could help with Central Region air defense. F-4s and F-14s could do so directly, if used in the air-to-air role. A-4s, A-6s, and A-7s could do so indirectly, by freeing multipurpose aircraft like the F-16 to perform air defense rather than ground-attack missions.

The Navy now operates these aircraft from carriers. The Marine Corps would probably do likewise in time of war, until its ground forces were landed in a combat theater. Since as many as one-third of the Navy's 13 carriers could be in overhaul

---

16/ A typical wing also includes around 30 additional aircraft of other types.

17/ The Marines also have some 900 aircraft of other types, including helicopters.

at the start of a war, it might be possible to use some of the fighters normally aboard these carriers in the early days of the air battle in Europe. It should also be possible to use some Marine aircraft in the same way. 18/ For these Navy and Marine aircraft to be operated from existing European airfields on short notice, necessary support and repair facilities should be prepositioned there.

The Marines presently have such facilities in readily movable form, as part of their "short airfield for tactical support" (SATS) capability. Additional sets of these facilities could be procured for Navy/ Marine Corps use and prepositioned at particular European airfields. Such measures would reduce both the need for airlift assets and the time required to make Navy and Marine air units operational in Europe in the event of war. 19/

Once such facilities were purchased, decisions would have to be made about where to preposition them. There are at least two conceptual alternatives. One would be to negotiate with the allies for the establishment of additional COBs. Another would

---

18/ The Marine Corps cannot undertake the division-sized landing operations that its air wings are structured to support on a few days' notice. It can only do so a few weeks after Marine resources--and Navy amphibious lift--are marshalled for that purpose. Even so, Navy amphibious assets can lift only about 1-1/3 of the Marines' three divisions. Therefore, the resources of at least one Marine air wing ought to be available for any European war that is not preceded both by long warning and the commitment of substantial Marine air resources to other contingencies. Accordingly, it would seem reasonable to consider the possibility of using one-third of the particular Marine aircraft types noted above in Europe. Such use would give the Commander of AAFCE an additional 41 F-4s, 30 A-4s, and 20 A-6s.

19/ Provision of such facilities is a necessary condition if Navy aircraft are to make a contribution in Europe. It is not, however, a sufficient condition. For example, "naval air units would have to exercise in the European land-based environment if they were to be useful when called." (Tactical Air Warfare, Hearings before the Task Force on National Security and International Affairs, House Committee on the Budget, 95:1 (June 1977), p. 32.)

be to plan to operate Navy and Marine Corps planes from European civil airfields. Since, in either case, the United States would probably want to construct the facilities--shelters, additional taxiways, etc.--that usually accompany COBs, the costs of both alternatives should be roughly comparable. Construction of these facilities at a civil airfield, however, would probably not enhance the passive air defenses of allied forces as much as would emplacing them at COBs.

Background Notes on NATO Fighters

Allied Fighters. Several points made in the text about allied fighter forces are worth amplifying here. It was noted in Chapter III that the allies deploy a number of aircraft of national manufacture. These include 20 of the relatively old Lightning aircraft deployed with Britain's Royal Air Force and 15 Mirage IIIC and 90 Mirage F-1 aircraft in service with the French air force. It was also noted that Belgium and the Netherlands intend to acquire the F-16 for use in the Central Region. Belgium plans to procure 116 F-16s, and the Netherlands, 48.

Chapter III also stated that the British Tornado ADV "may be available" for defense of the Central Region. This prediction was not made more forcefully for an important reason. The development of this type of aircraft will doubtless be very expensive, and development costs will be difficult to amortize over the production run of 165 aircraft. As a result, Great Britain may well decide against production of the Tornado ADV.

U.S. Fighters. The F-15 was described in the text as a highly sophisticated aircraft, designed specifically for the air superiority mission. Additional details about this system are worth noting here. The F-15 is being procured to counter low-, medium-, and high-altitude threats under all-weather day or night conditions, but it is also capable of performing ground-attack missions. The F-15 carries both infrared and radar missiles. Thus, some of its advertised superiority to the F-16 depends on the quality of IFF systems that will permit its radar missiles to be used beyond visual range. Nevertheless, the F-15 is superior in range, maneuverability, speed, and sophistication to the F-4, which it is replacing. In addition, the F-15 is likely to be more difficult to spot visually because its engines do not emit smoke.

CENTRAL REGION EARLY WARNING SYSTEMS

Ground-Based Radars

Early warning is in part provided for NATO by its NADGE (NATO Air Defense Ground Environment) system. This consists of some 80 fixed-site radar stations, stretching from northern Norway to eastern Turkey. 20/ There are some serious flaws in the NADGE system, however. Its stations are immobile, and many of them are highly visible, sitting on the tops of hills in large cleared areas. For these reasons, they might be vulnerable to air attack. Finally, NADGE radars provide only line-of-sight coverage, so that aircraft flying at low altitudes can penetrate the system undetected.

Warning of attacking aircraft in the Central Region is also provided by a recently developed system of mobile radars, termed the German Low Level Reporting System (LLRS). Apparently, these radars will be located in both northern and southern Germany, and will provide somewhat earlier warning of low-flying intruders than is given by the NADGE radars.

Airborne Warning and Control System (AWACS)

As noted in the text, AWACS is an airborne early warning radar. According to the Air Force, AWACS has the capability to detect and track enemy aircraft, relay the information to air and ground commanders, and assist in managing air battles. The Defense Department plans to procure 34 AWACS for use in the United States, Europe, and wherever else the United States might be involved in hostilities or imminent hostilities. Funds have been appropriated through fiscal year 1978 for 22 AWACS.

The AWACS seems to be an improvement over ground-based radars. Since elements of the Pact ground attack air force

---

20/ There are some gaps in the system, notably over Switzerland, the eastern Mediterranean, and Iceland. (See "Evolution in Air Defense Requirements," International Defense Review, No. 3 (1974), p. 314.) For additional information on the NADGE system, see Congressional Budget Office, The U.S. Sea Control Mission: Forces, Capabilities, and Requirements, Background Paper (June 1977), pp. 12-13.

might try low-altitude penetration, and since ground-based radars often cannot detect such intrusion, it is important to have a system that can direct NATO fighters toward low-flying Pact penetrators. Air Force sources state that AWACS is able to do this because of its capability to look down and detect low-flying aircraft. Proponents also claim that AWACS would be important at the outset of a war in detecting where the initial air attack would occur, especially if warning time was short and an attack would have to be countered with limited resources.

If its proponents' arguments are valid, the presence of AWACS in a NATO war could be a significant contribution to overall NATO air defense. Procurement of the AWACS beyond the 22 already purchased might not, however, bear greatly on overall Central Region air defense capability. The Air Force believes that 19 operational AWACS would be adequate to meet vital U.S. interests in Europe, and it apparently places first priority on deployments there. 21/ As noted earlier, the United States has already appropriated funds for 22 AWACS, and Britain plans to buy 11 Nimrod airborne early warning aircraft. Since the Air Force says it needs 19 AWACS for Europe but funds for 22 have already been appropriated by the Congress, a decision to procure additional U.S. AWACS should probably be made in the context of its missions outside of the Central Region.

NATO Airborne Early Warning and Command System (AEW&C)

The NATO AEW&C aircraft is often called NATO AWACS because it is a modified version of the U.S. AWACS. The NATO Defense Ministers accepted the military requirement for the NATO AWACS in December 1976, but no final procurement decision has been made. Original plans for NATO AWACS procurement called for a force of 27 aircraft, in addition to the AWACS that the United States would supply. Later, when the British decided to purchase 11 Nimrods, the total requirement for NATO AWACS was reduced to 18.

21/ Fiscal Year 1978 Authorization for Military Procurement, Research and Development, and Active Duty, Selected Reserve, and Civilian Personnel Strengths, Hearings before the Senate Committee on Armed Services, 95:1 (March 1977), Part 5, p. 3401.

All NATO military members, including the United States, are involved in procuring NATO AWACS, although at different levels of financial participation. The U.S. share of the program was originally set at 27 percent, the largest share. The British withdrew from financial participation when they decided to purchase Nimrod. The U.S. share of the revised program has not yet been determined, but it is likely to be about one-third. This cost would be in addition to the funds the United States has already appropriated for AWACS.

Funds were requested by the Defense Department in fiscal year 1978 for research and development on NATO AWACS. The Defense Appropriations Act for fiscal year 1978 included $15.7 million for this purpose, with the stipulation that the funds not be obligated or expended until at least one NATO country entered into a contract to purchase AWACS. The conference report accompanying this legislation also suggested that NATO be required to pay a surcharge on prior research and development costs. 22/

The reservations expressed by the Congress about proceeding with NATO AWACS procurement have been matched by caution abroad. Important elements within the German government, which would be the principal European contributor to the system, seem unenthusiastic. The German Air Force is concerned that as many as 120 NATO fighters would have to be committed to the defense of the AWACS. More generally, the German military apparently believes that the AWACS will give six or seven minutes' more warning of an impending attack, but doubts that this is worth its high cost. Other German officials have expressed only qualified support for the system. For example, Defense Minister Leber favors the program only if the main operating base for the system would be located in Germany. Other German officials do not want to proceed with procuring NATO AWACS unless German expenditures would be matched by comparable levels of U.S. spending on German weapons systems.

If the Congress had not already appropriated funds for procuring 22 U.S. AWACS aircraft, the significance of NATO AWACS for Central Region air defense would be greater than it is.

22/ Department of Defense Appropriations for Fiscal Year 1978, Conference Report of the House and Senate Committees on Appropriations, House Report No. 95-565, 95:1 (August 1977), p. 48.

According to the Air Force, AWACS would overcome some air defense deficiencies and enhance the effectiveness of other air defense systems. If the allies did not proceed with NATO AWACS, however, but U.S. AWACS were made available for use in a war in the Central Region, a gaping deficiency in overall air defense would not result. Instead, lack of NATO AWACS would likely mean only a diminished ability to continue AWACS operations at the same rate if any U.S. aircraft were destroyed. 23/

Some of its proponents characterize NATO AWACS as an example of a joint solution to an alliance problem. It may be, however, that the effort--a substantial financial undertaking for the United States and the alliance--is being made in an area where U.S. initiative and the U.S. defense budget have already solved the greatest part of the problem.

23/ AWACS proponents make another argument for NATO AWACS that goes beyond the needs of the Central Region. This argument posits that there are also requirements for AWACS on the flanks. If so, the U.S. purchase would be insufficient to meet all the requirements, and NATO AWACS would be important to overall alliance defense.

APPENDIX B. THE RATIONALE FOR A VISUALLY GUIDED ANTI-AIRCRAFT GUN

Each of the budget options in Chapter IV proposed a visually guided, clear-weather capable gun, similar to the 35 mm. tank chassis-mounted DIVAD system, but without the all-weather capability associated with the latter's radar guidance. This proposal was based on two points.

The first point was that such a visually guided gun might successfully defend front-line forces against Pact attack helicopters as effectively as a more expensive, radar-guided weapon. This observation is based on three considerations:

- Any improvement resulting from radar guidance could be eroded, if not negated, by the tactics used by Pact helicopters; that is, by flying close to the surface of the earth, these helicopters could offset the advantages in detecting or engaging targets that might otherwise be provided by radar guidance.

- Pact helicopters rely on visual guidance to direct anti-tank missiles to their targets and, in doing so, the helicopters expose themselves to visually guided fire from the ground. Army manuals state that the helicopter would be "extremely vulnerable" during this period.

- Since the simpler anti-aircraft gun is less expensive to produce, more of these weapons could be deployed for the same cost. Therefore, the overall defense against Pact helicopters might well be enhanced.

The second point was that systems capable of engaging Pact fixed-wing aircraft in bad weather might not be needed at the front. This observation is based on the Pact's limited all-weather capabilities, both now and in the foreseeable future. 1/

1/ This argument assumes that recent Soviet aircraft production rates will remain about the same and that the Pact will not quickly develop and deploy a new aircraft type that would be effective in all-weather ground attacks.

Four all-weather jets are now in service with Pact forces. These are the TU-16 Badger (a very old medium-range jet bomber), the TU-22 Blinder (a supersonic bomber and maritime patrol aircraft), the Backfire (a supersonic bomber designed for long-range missions), and the SU-19 Fencer (a swing-wing fighter bomber sometimes compared to the U.S. F-111). Of these aircraft, only the Fencer is assigned to Frontal Aviation, the organization charged with supporting Pact ground forces directly. One hundred-fifty Fencers are now in service (representing about 4 percent of the present Frontal Aviation inventory in Central Europe and the western Soviet Union); 600 Fencers (representing around 13 percent of the total projected inventory) are expected to be in service by 1985.

The Fencer is a highly capable aircraft. Even if all Fencer sorties were flown against NATO forces at the front, however, they would add relatively little to total Pact firepower potential there. Most Pact firepower at the front would be provided by artillery and tanks, and Fencer sorties would probably not be as effective as these systems against the small, dispersed targets presented by NATO's front-line forces. The Fencer could be effective against distant, less mobile targets, however. Therefore, scarce Fencer resources would probably be directed against high-value targets in NATO's rear areas and not used extensively in ground-attack roles at the front. In other words, if the Army's objective is to reduce the firepower to which its forces could be subjected in bad weather, Pact jets would be a relatively small part of the problem. Yet, as noted in the text, a major reason the Army presents for making extremely costly investments in all-weather capabilities for its DIVAD gun is defense against Pact jets.

GLOSSARY

Active Air Defense: The use of measures that destroy enemy aircraft or reduce their ability to accomplish their missions by threatening such destruction.

Blowpipe: British shoulder-fired, radio-command guided, short-range SAM.

Central Region: The part of NATO's defenses that stands behind West Germany's border with East Germany and Czechoslovakia.

Chaparral: U.S. vehicle-launched, heat-seeking, short-range SAM.

Collocated Operating Base: An allied air force base at which facilities are constructed to permit operation of U.S. fighters in time of war.

F-4: See Phantom.

F-15: A highly sophisticated U.S. air superiority fighter, armed with Sparrow and Sidewinder missiles. The former give it all-weather, beyond-visual-range potential.

F-16: A small U.S. multipurpose fighter, armed with Sidewinder missiles and a 20 mm. cannon. It has excellent potential for visual-range, air-to-air combat.

Fencer: NATO code name for the Soviet SU-19 all-weather, ground attack aircraft.

Hawk: U.S. SAM, intended for use at low and medium altitudes. Presently deployed by Germany, Belgium, the Netherlands, and the United States.

Hind: NATO code name for the Mi-24 Soviet attack helicopter.

NADGE: NATO air defense network linking nine European countries. Includes about 80 radar sites and electronic transmission facilities.

Nike-Hercules: U.S. long-range SAM, intended for use at medium and high altitudes. Presently deployed by Germany, Belgium, the Netherlands, and the United States.

NORTHAG: Northern Army Group. A subdivision of NATO forces in West Germany including Belgian, British, Dutch, and West German corps sectors.

Passive Air Defense: Preparation of potential targets so that they are harder for enemy aircraft to find or destroy.

Patriot: U.S. SAM, intended for coverage of low, medium, and high altitudes. Presently under development.

Phantom: U.S. supersonic, multipurpose fighter in service with the British, German, and U.S. Air Forces. Family designation is F-4, although British models are designated FG-1 and FGR-2.

Phoenix: U.S. Navy long-range, radar-guided, air-to-air missile. Family designation is AIM-54.

Rapier: British, short-range, radio-command guided SAM.

Redeye: U.S. shoulder-fired, heat-seeking SAM.

Roland: Franco-German designed SAM, currently produced in the United States as well as Europe, to be deployed with the French, German, and U.S. armies.

Sidewinder: U.S. heat-seeking, air-to-air missile. Family designation is AIM-9; particular models are distinguished by letters that follow (e.g., AIM-9L).

Skyflash: British, radar-guided, air-to-air missile. It uses the airframe, motor, and warhead of the U.S. AIM-7E Sparrow, but is equipped with a different autopilot, seeker, and fuse.

Sparrow: U.S. radar-guided, air-to-air missile. Family designation is AIM-7; particular models are distinguished by letters that follow (e.g., AIM-7F).

Stinger: U.S. shoulder-fired, heat-seeking SAM. Currently under development as a replacement for Redeye.

Vulcan: U.S. 20 mm. multibarrel AA cannon, deployed on self-propelled and towed mounts.

ABBREVIATIONS

AA:	Anti-aircraft.
AAFCE:	Allied Air Forces Central Europe.
ADV:	Air Defense Variant.
AIM:	Air Intercept Missile.
AWACS:	Airborne Warning and Control System.
CENTAG:	Central Army Group.
COB:	Collocated Operating Base.
LLRS:	Low Level Reporting System.
NADGE:	NATO Air Defense Ground Environment.
NORTHAG:	Northern Army Group.
SAM:	Surface-to-Air Missile.
SHORAD:	Short-Range Air Defense.